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STARTUPS AND ARTIFICIAL INTELLIGENCE

Innovation Meets Responsibility

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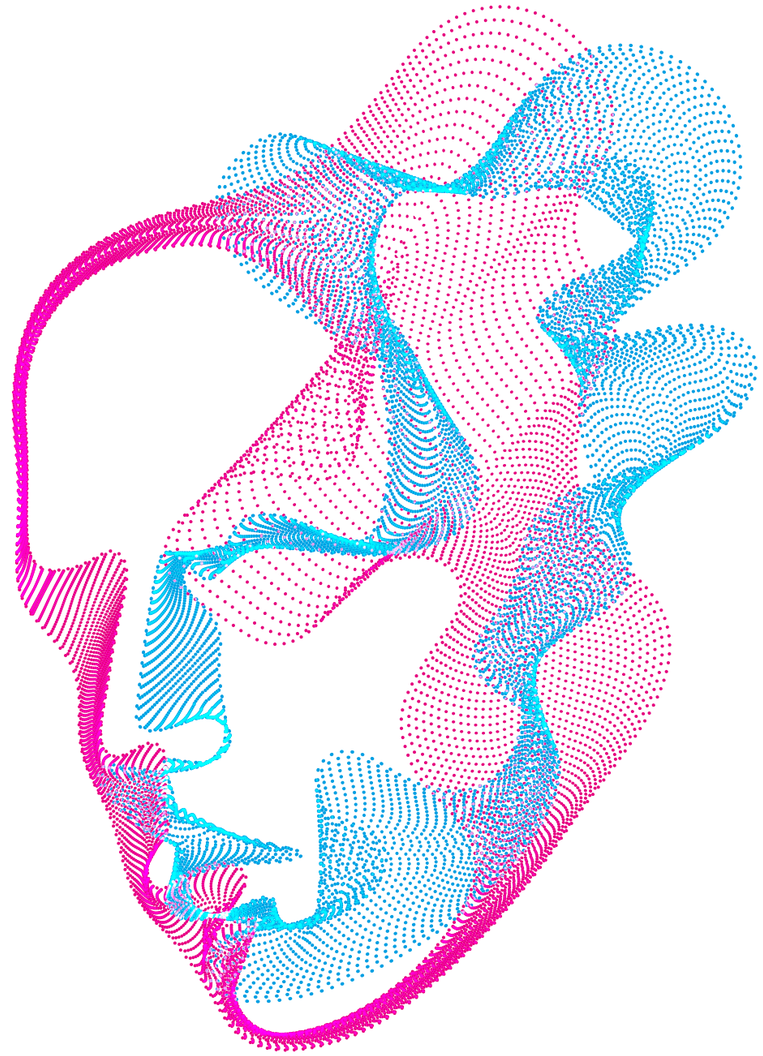

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PREFACE

For 43% of German startups, AI has a distinct impact on their business model. This number illustrates the central role of startups for the transfer of technological innovation into practice. Our study also shows that there is significant potential for further development. Founders in the AI sector possess of the very characteristic that is urgently needed for digitalisation and economic transformation – a willingness to take risks and the ability to think big. There are twice as many AI startups with the ambition of becoming a unicorn compared to the startup sector as a whole.

This is encouraging! Startups are, after all, not only important for the economy, but have a considerable social significance, too. They are “fast moving” companies and, as such, a fundamental factor on the road to more digital sovereignty in Europe. If we Europeans are not at the vanguard of AI, we will miss out on actively shaping crucial technologies and business areas. Therefore, it is essential to improve the financial resources of startups in the AI sector – especially with regard to strategic and VC investments. Here, the USA and Israel are benchmarks.

If we all pull together in the field of AI, Germany and Europe will have a chance of playing a leading role: By emphasizing human-centred AI, we are creating a clear profile, also in international competition. Now we need to promote responsibility and innovation simultaneously in order to leverage our USP. This is particularly important since ethics and trust are becoming increasingly relevant for customers as well as for providers in the field of AI.

One key aspect that we need to prioritize in this context is diversity and, specifically, gender equality: We need more women in the AI sector! Empowering women in AI means to enable equal participation in the development of new technologies and to draw from a wealth of talent. A technology as powerful as AI places special demands on our digital responsibility – diversity among those who shape it is therefore of the utmost importance.

We hope that our study will contribute to the further development of the German and European AI ecosystem and that you enjoy reading it.

Claudia Nemat, Board Member Technology & Innovation,
Deutsche Telekom AG

Christian Miele, Chairman of the German Startups Association

KEY RESULTS

01

STARTUPS PUT AI INTO PRACTICE

For 43% of German startups, AI has a clear impact on their business model. AI startups are pioneers in the fields of Industry 4.0 and Internet of Things. This makes them one of the driving economic factors in collaboration with the established economy.

02

AI STARTUPS THINK BIGGER

17% of young AI companies aim at a company valuation of over € 1 billion, compared with only 9% across the ecosystem – they are also more likely to want to go public. AI startups take a leading role in the global competition for unicorns and tech champions.

03

LACK OF CAPITAL

Investments per capita in AI startups in the US are currently 10 times higher than in Germany. In Israel they are even 19 times higher. The demand for strategic and VC investments is particularly high, highlighting the German economy‘s reluctance towards AI and deep tech.

04

WOMEN ARE UNDERREPRESENTED

The share of female founders in the AI sector is only 12% and thus clearly below the average in the startup ecosystem (18%) – the same is true for employees (29 vs. 38%). This large gap in talent and participation must be closed.

05

RESPONSIBLE AI

There is consensus among German AI startups on the need for ethical guidelines. 88% want to assume social responsibility and 81% think that ethical issues must also be taken into account when developing technology.

06

DIVIDED VIEWS ON REGULATION

47% of the startups surveyed view European AI regulation positively as a way of establishing trust and a European USP. However, legal uncertainties and questions of practical feasibility pose major challenges for AI startups.

07

RESEARCH TRANSFER IS KEY

Startups with close ties to universities and research institutes account for 33% of AI startups and play a central role in the AI sector. By international comparison, however, Germany is still poorly positioned in terms of AI education and transfers.

08

AI STARTUPS ARE DIGITALISING OUR INDUSTRY

In terms of value creation and maturity of solutions emerging from AI startups, the greatest potential in Germany lies in industrial applications. This can only be achieved with access to relevant company data, which 64% of AI startups stated needs to be improved.

1. AI MADE IN GERMANY

1.1. MOTIVATION AND OBJECTIVES

Voicification, personalised education or the optimisation of production lines and energy systems together with many other applications of artificial intelligence have seen wide adoption and are driving the next wave of digital transformation. From video conferencing tools to cloud services, the COVID-19 pandemic has also brought Europe‘s deficits regarding domestic digital solutions into the focus of the public – putting the discussion around digital sovereignty at the centre. But how can we shape AI innovation in Germany and Europe and strengthen our ecosystem so that we can make better use of major technological advances? Apart from looking at the great potential of AI itself, we should also consider that AI applications are the starting point for various social challenges - from the issue of data protection to problems of discrimination. It is imperative here to assume responsibility and to build trust.

An understanding of how closely innovation and responsibility are linked in the field of AI is elementary. If no internationally competitive AI solutions are developed in Germany and Europe in the coming years, we will not be able to contribute to shaping the technology and how it is being used. Instead, we will be faced with one-sided dependencies which are already all too familiar in many other areas of the digital economy, such as search engines, online platforms, and social networks. In the end, it will then be of little use to insist on our own values and guidelines.

To counteract this development, the position of Germany as an innovator in AI must be strengthened and, at the same time, the social challenges of the technology addressed. The aim of this study is to identify the key factors required to achieve this and to illustrate the added value of AI applications through practical examples. To this end, the focus is on AI startups, the most important indicator of economic and social transformation. This study follows on from the 2020 report „Artificial Intelligence: The State of German Startups“ and focuses on opportunities for further development of the ecosystem: How can we push German AI startups forward in international competition? What are the key factors for the development of the ecosystem? And what role do ethics, regulation, and digital sovereignty play?

1.2. INNOVATION, RESPONSIBILITY, AND SOVEREIGNTY

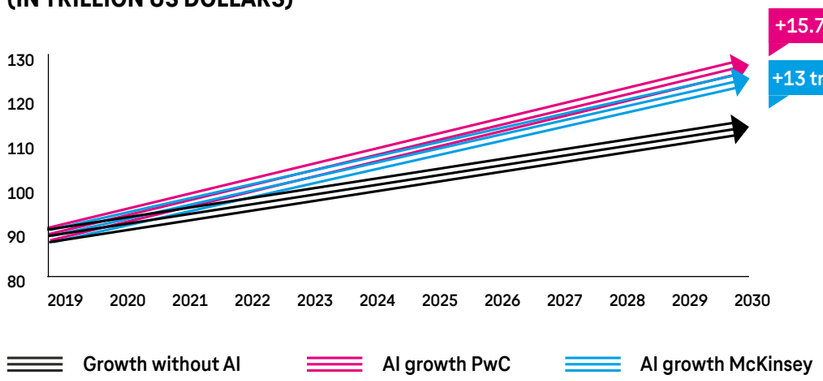
In order to grasp the economic and social importance of AI, it is worth briefly outlining the concept. AI is about developing models that possess abilities usually attributed to humans: these include learning, logic and, in extreme cases, even abstract

thinking. Very advanced AI models exist in the area of language modelling, for example. Based on the analysis of comprehensive data, AI is able to produce text and answer questions itself.

AI can help solve relevant social problems – in the field of medical diagnostics, for example – or increase the efficiency of industrial production and thereby contributes immensely to economic development. Alongside the emergence of new business areas, the positive effect on productivity resulting from increasing automation and higher system reliability should be emphasised. The improvements in efficiency can be seen in both physical manufacturing as well as in the field of knowledge-based activities – when working with research or customer data, for example. Model calculations predict that these developments will add more than one percentage point to annual global economic growth in the coming years (McKinsey Global Institute 2018, PwC 2018). AI could consequently become a central driver for growth after the dampening effect of the COVID-19 pandemic.

Figure 1: Economic significance of artificial intelligence

EXPECTED ADDITIONAL GROWTH DRIVEN BY AI (IN TRILLION US DOLLARS)



Source: McKinsey Global Institute (2018) & PwC (2018).

As more and more AI applications are coming into use, the social consequences of the technology are also gaining in importance, especially when decisions are made that have a direct impact on people. Within the context of AI, an increasing number of questions are therefore being raised about data protection and state guidelines for handling the technology. The debate is driven by extreme examples such as the police use of facial recognition software, which has been implemented in some countries. Arrests of innocent people based on false-positive data matches have

led to criticism of such applications, particularly because ethnic minorities are more often the victims of errors, thus reproducing or even intensifying existing forms of discrimination (New York Times 2021). In addition, the fundamental question arises as to the legitimacy of intrusions into personal rights by governments or businesses. This makes it clear how important it is to have targeted regulations in place that address legitimate social concerns and at the same time create the necessary trust in the vast majority of uncritical AI applications.

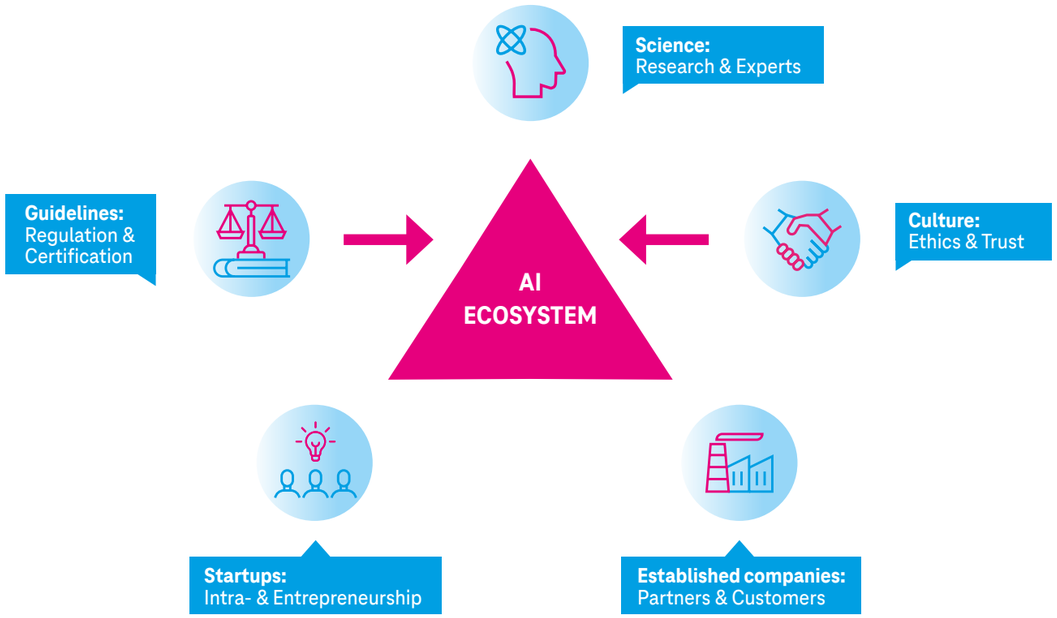
1.3. FOCUS AND METHOD

The central topics of this study are the connection between innovation and trust and the conditions for creating a powerful AI ecosystem in Germany. As in our 2020 publication “Artificial Intelligence: The State of German Startups”, the focus is again on young and innovative growth companies. This is because startups put innovative products and solutions into practice quickly, deal with ethical challenges at an early stage and are therefore a key indicator of the economic and social progress in the AI sector.

If the AI ecosystem is to develop positively, a successful interplay between startups, research and the established economy is required. The dynamics and quality of startups depend heavily on the conditions in the startup scene, particularly when it comes to funding and mindset (Chapter 2). In addition, AI startups benefit from a close exchange with the academic world – think spin-offs and experts – as well as from strategic collaborations with the established economy (Chapter 4). In addition to these three dimensions of the ecosystem, the social and regulatory environment, and with these the trust of users, play a decisive role, particularly in the field of AI (Chapter 3).

One of the central data sources used in the study is the German Startup Monitor (GSM) 2021 (Kollmann et al. 2021), which allows for the identification of AI startups and a separate re-analysis. Information from a total of more than 2000 startups and around 440 with an AI focus can be assessed – a subset comprised of companies which have indicated that AI has a very big impact on their business model.[1] In addition, data from various sources are included in the analysis, especially those that enable international benchmarking – such as the Stanford AI Index (Zhang et al. 2021) and data from the "What can AI do for me?" project (Seitz et al. 2021).

Figure 2: Conceptual framework



1) All of the following figures are based on data from the German Startup Monitor unless indicated otherwise.

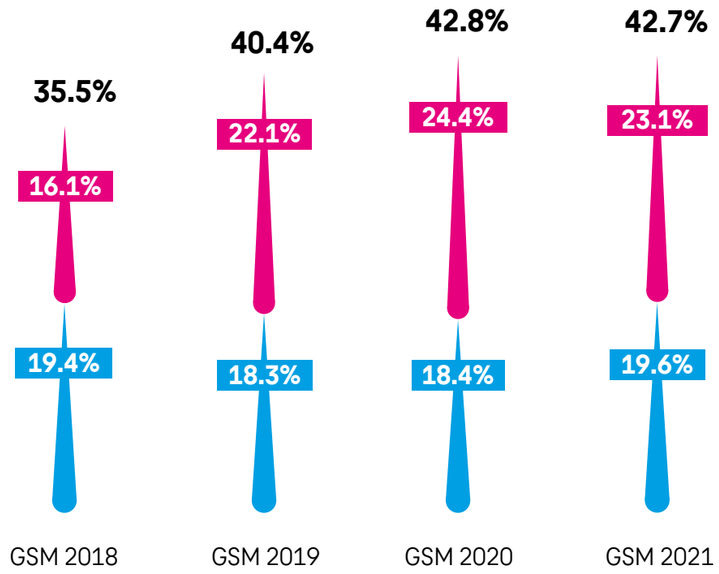
2. STARTUPS AND THE AI TRANSFORMATION

2.1. AI IN THE GERMAN INNOVATION ECOSYSTEM

As a key technology of digitalisation, AI is also becoming increasingly important in Germany – especially in the startup ecosystem. This development is underlined by GSM data: Until 2020, AI grew steadily in importance among startups and is now at a constant level of 43% (fig. 3). This means that AI can increasingly be seen as a cross-sectional technology that is relevant for virtually every company – regardless of industry or business model. However, the fact that we are now seeing stagnation for the first time after the increase in recent years is also a warning signal: while the demand for AI continues to rise, the conditions for startups are significantly better in many other countries than in Germany. Furthermore, the dominance of international corporations poses major challenges for AI startups in Germany.

AI startups are key drivers of innovation in future fields such as Industry 4.0 and the Internet of Things (IoT), since powerful algorithms are essential for the processing and use of the large volumes of data required by networked and intelligent industrial and IoT applications. The strong connection between AI startups and these two sectors is clearly reflected in the GSM data. The analysis of business models underscores the tech focus of AI startups and their relevance for the established economy. For example, as in the previous year, SaaS together with software and technology development clearly dominate over traditional digital business areas such as online platforms and e-commerce. The central significance of telecommunication technologies points to the high relevance of network infrastructure for AI companies. Compared with previous years, the manufacturing, transport and mobility and healthcare sectors continue to expand. These startups cover a wide range of applications from robotics to machine monitoring, autonomous vehicles, and diagnostic software (appliedAI 2021).

Figure 3: Impact of AI on the business models of German startups



Own analysis German Startup Monitor 2018–2021

High impact **Very high impact**

"Autonomous driving is largely tested in simulations – so mostly in scenarios similar to the motorway, which are far less complex than traffic in city centres. However, predicting unexpected situations such as when pedestrians suddenly step onto the road is crucial for a high degree of safety. This is where we come in, using artificial intelligence to develop models that take just that into account."

***MARIA MEIER,** Co-Founder & CTO Phantasma Labs*

"Even in my professional career before founding AiSight, I saw the challenges faced by companies in implementing predictive maintenance on their production lines. With our sensor kit and accompanying software, AiSight provides its customers with an easy-to-use solution for production monitoring and predictive maintenance in industrial facilities – something that was often complex and expensive in the past. Since we started in 2018, we have been successful in convincing both medium-sized companies and large corporations of our solution and helping them to further optimise their production processes."

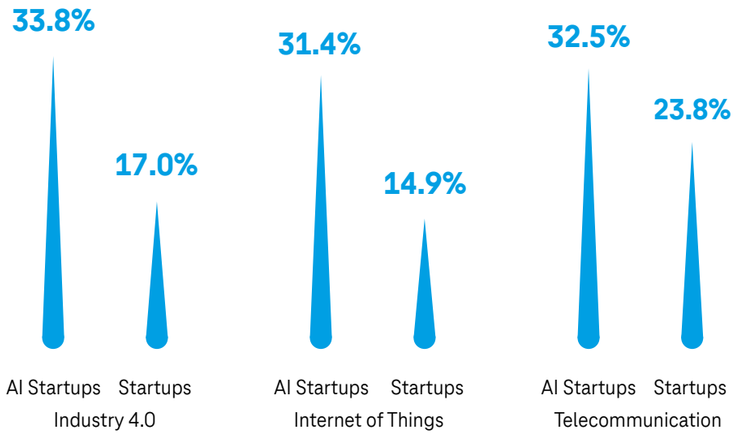
***MATTHIAS AUF DER MAUER,** Founder & CEO AiSight*

"With our startup Zana, we want to apply AI and language technology in the healthcare sector. This means offering our products in a sector that is already heavily regulated today. For young AI startups, it is a great challenge to keep track of and comply with new AI regulations and data protection rules as well as all the other specifications in the healthcare sector that already exist. It is therefore very important for us not to create any new hurdles to market entry, but to find a way to merge regulations, speed up processes and thus create opportunities for more young companies."

***DR. JULIA HOXHA,** Co-Founder & CEO Zana*

Figure 4: AI Startups & Technologies

VERY HIGH IMPACT ON THE BUSINESS MODEL

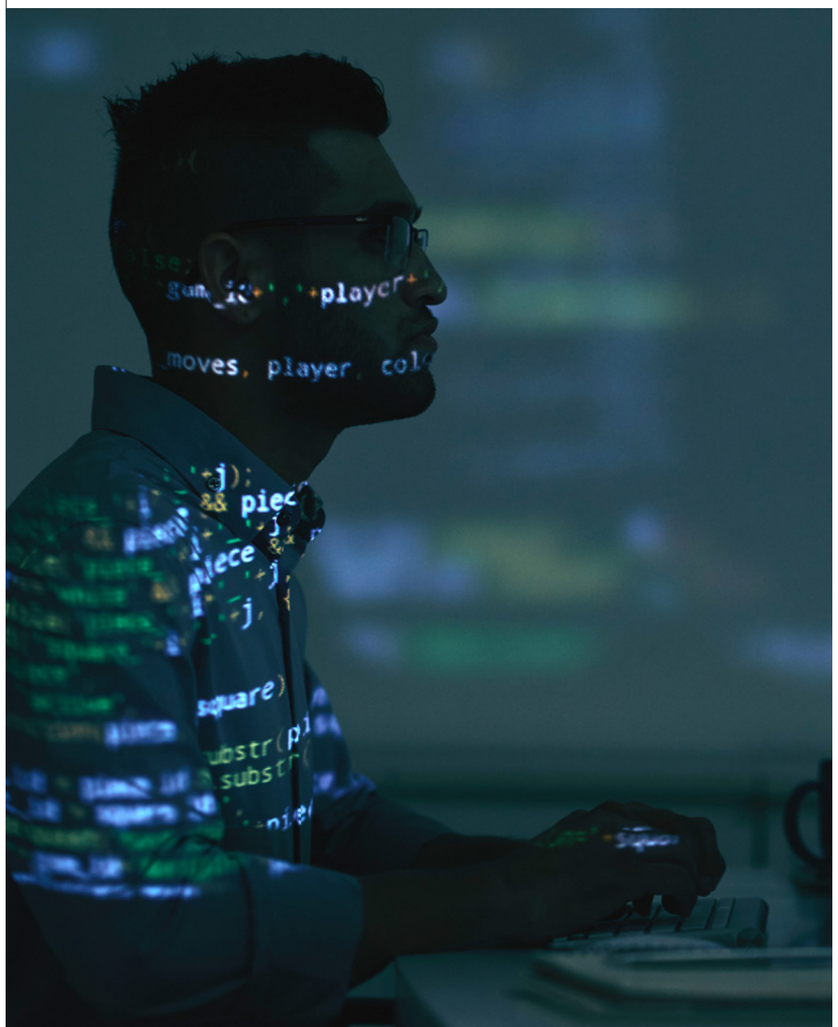


Own analysis German Startup Monitor 2021

Future industrial applications of robots are demonstrated by the Munich-based University spin-off Agile Robotics, which recently became a Unicorn: The combination of modern sensors and optimised software is designed to take industrial robotics to the next level with the help of AI. Industry 4.0 offers huge potential for AI startups in Germany. Whereas innovation processes in the established economy take years or even decades to realise due to rigid structures and a focus on existing business models, startups implement new technologies much faster and more widely. Their speed and disruptive potential are decisive competitive factors in the digital transformation. The associated economic significance is already visible today: 415,000 people currently work in startups and scaleups in Germany, which is about 1% of total employment. The 55% increase over the last two years and a comparison with the US, where about 8% of employees already work in this sector, illustrate the vast economic opportunities (Roland Berger et al. 2021).

“We are witnessing incredible momentum in AI, strongly driven by the big digital companies. At the same time, there are also many open source developments that enable smaller and young companies in particular to use AI. For us, one of the most exciting fields of AI application is customer interaction and the individualisation of customer experiences – for example in the field of voicification. Our aim is to use AI to offer tailored dialogues as well as product and service experiences for every customer. At the same time, we stress the importance of a confidential and transparent handling of our customers‘ data.”

***JAN HOFMANN,** VP Top Program Lead AI Deutsche Telekom*



USE CASE: AI IN EDUCATION

From one day to the next classroom teaching was no longer possible – the COVID-19 pandemic placed a huge strain on our education system: Suddenly, virtual classrooms were needed across the board, teachers had to adapt to new formats, and families faced enormous challenges in their daily lives. But how much of this will remain when the crisis is overcome? Personalised learning has long been considered a teaching ideal. Faced with large and usually heterogeneous groups, however, putting this into practice is a real challenge. Digital offerings can help to improve everyday educational life, be it through individualised forms of learning, organisational support, or flexibility in terms of place and time.

In Germany, however, we lag far behind in the development and use of these new applications, something that became painfully clear during the COVID-19 pandemic. The economic potential of digital applications in the education sector is enormous: offerings and usage have globally grown rapidly in recent years, and current estimates forecast the market volume of the education tech sector to increase from currently about US $ 230 bn. to over US $ 400 bn. by 2025 (Dealroom 2021b).

Startups are also increasingly discovering the potential of this growth market: Worldwide, there are now 37 startups in this sector that have achieved unicorn status – predominantly in the US (20) and China (14). However, of the € 7.2 billion in VC investments worldwide in the first half of 2021, only € 105 million flowed into Germany (Dealroom 2021b). It is precisely these startups, though, that are driving innovation by addressing relevant technological trends and making them accessible to the education sector. The use of AI solutions plays a central role here.

The possibilities for using AI technologies in education focus primarily on individualised and adaptive learning. Alongside text data, more and more language and image data is being used, opening up new areas of application – for example in the creation of graphics in mathematics and natural sciences. In addition, there are already some applications that incorporate facial expressions, gestures and behaviour of learners into the process. It is particularly in this field that the issue of ethics and questions of the boundaries of AI in education become highly relevant – transparency and trust are crucial factors here.

Internationally, China and the US are the pioneers in this field, too. A prominent example is the Chinese provider SquirrelAI. Founded in 2014, the company claims that over 10 million students are currently being tutored in their learning centres, up to the level of the nationwide university entrance examination. The South Korean startup Riiid, which now prepares nearly 2.5 million people for the TOEIC English exam, also recently attracted attention with US $ 175 million in funding from SoftBank. Europe and Germany lag far behind these major international competitors in terms of both research into relevant technologies and their implementation in functioning business models (Schmid et al. 2021).

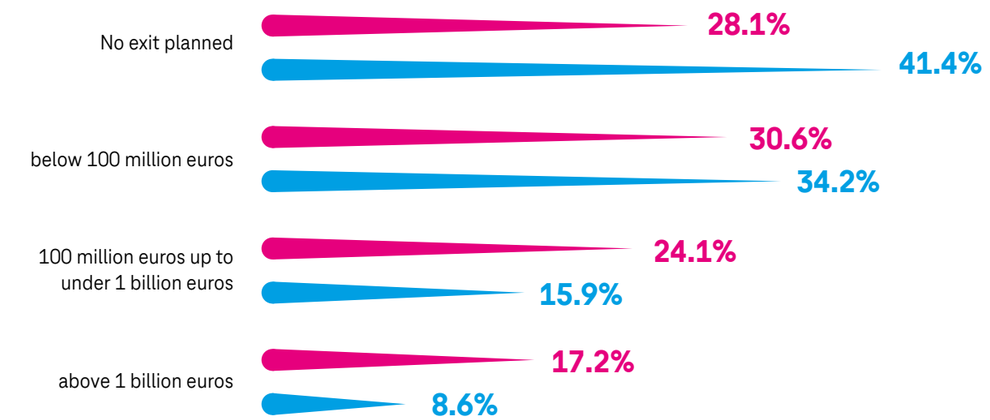
At the same time, there has been some movement in EdTech recently in the DACH region: One of the best-known German startups in this field is StudySmarter, which cooperates closely with textbook publishers and schools in order to offer a range of cross-curricular courses in the field of adaptive learning. Austria is home to GoStudent, which became Europe's first EdTech unicorn to date, following a high Series C funding round in June 2021. While other EdTech startups are rather careful with the use of the term AI in public, GoStudent explicitly advertises their goal of making online tutoring more transparent than before with the help of AI. For this purpose, both students and teachers are filmed and analysed regarding their emotions, to see what makes a lesson successful.

> ***"We still have a lot of catching up to do when it comes to the digitalisation of education in Germany – partly because we didn't start taking the subject seriously until far too late. Not only is there a lack of digital learning tools, but above all the necessary skills are missing. This became painfully clear during the coronavirus crisis, and in the end it came down to the individual teacher how quickly and comprehensively the transition could be made. If we want to make our education system fit for the future, we need to be more open to innovation, including AI, for example, which has so much future potential, and we must also be willing to try out new things. This does not mean ignoring the risks, but rather comprehensively assessing the impact of digital applications. In doing so, we should focus on the pedagogical and didactic concepts that we want to support digitally."***
>
> ***DR. EKKEHARD WINTER,** Managing Director Deutsche Telekom Foundation*

2.2. MINDSET, FINANCING, AND GROWTH

In addition to their clear focus on deep-tech applications, founders of AI startups are characterised by an ambitious mind-set. They aim for an exit much more often than startups in general and think bigger – about one in five AI companies surveyed has the goal of reaching a valuation of over one billion euros. It‘s also worth noting that 35% of exit-oriented AI startups (25% startups in general) have an IPO in mind as a possible exit scenario. This is good and important news also for the entire eco-system, because this is precisely where the ambition to create more German tech champions can become a reality.

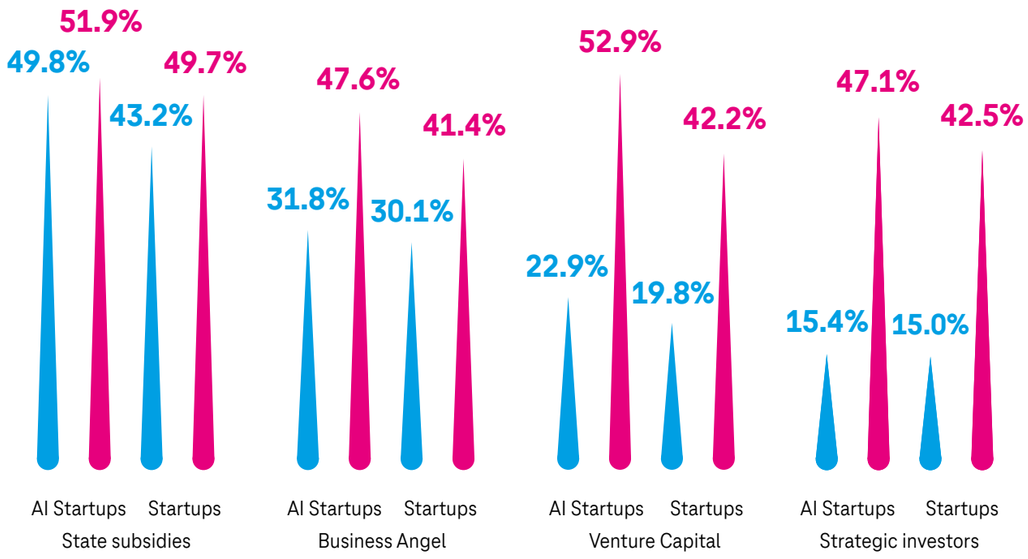
Figure 5: Exit and Unicorn ambitions



Own analysis German Startup Monitor 2021

Growing investment sums and company valuations prove that the expectations presented are not pulled out of thin air. For example, in June 2021, the AI startup Celonis received the record funding sum of US $ 1 billion, increasing its valuation to more than US $11 billion and making it the first German Decacorn. Against the background of the generally positive development, the GSM data provides a differentiated picture of the funding situation for AI startups (fig. 6): The breadth of government funding must be emphasised as this is particularly relevant in the early phases and about half of all AI startups benefit from it. However, when it comes to growth financing in the form of venture capital, AI startups rank only slightly higher than the general average. In addition, the funding gap, the difference between preferred and received capital, is higher. This means that the more ambitious growth plans of AI startups are not reflected to the same extent in the investments.

Figure 6: A comparison of relevant startup funding

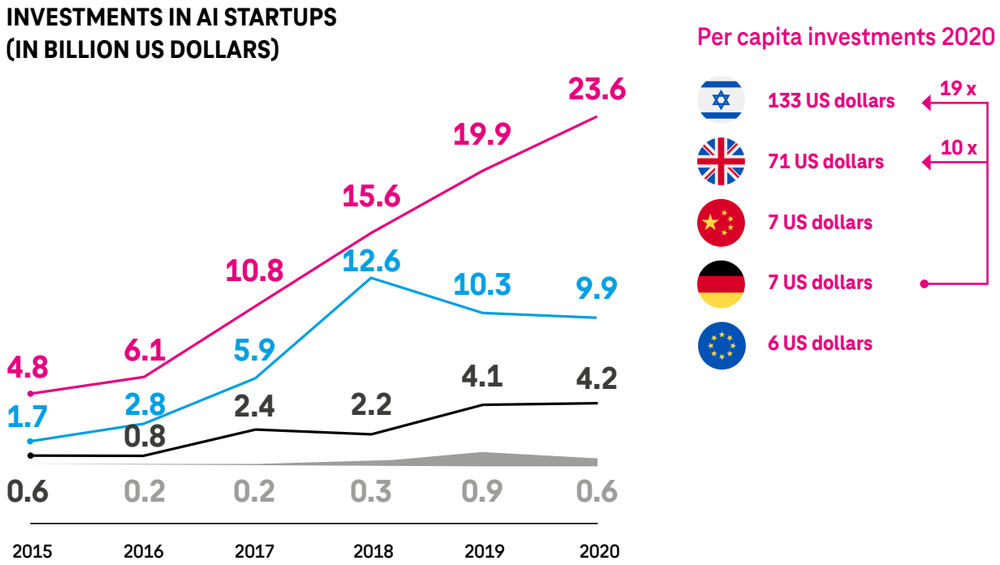


Own analysis German Startup Monitor 2021

Received Preferred

This funding deficit and the ensuing brake on growth are particularly visible in an international comparison: per capita investment in AI startups is around 19 times higher in the powerhouse Israel than in Germany and 10 times higher in the US. It is to note that this gap in the level of venture capital investment is smaller if we look at the startup landscape as a whole, where it is only 4 to 5 times higher per capita in these two countries compared with Germany (Dealroom 2021a). While investors in Germany are still cautious when it comes to deep-tech topics such as AI, the figures in Israel and the US show that opportunities in the field of AI are more likely to be recognized in innovation centres and startup hotspots. In Germany and Europe, on the other hand, domestic startups have less scope for company growth or rather there are fewer incentives in this direction. As a result, companies tend to remain smaller, focus on perfecting the product rather than scaling it, and limit themselves to regional or national markets. The topics of growth and internationalisation are thus addressed less frequently and existing potential not fully exploited.

Figure 7: AI startup funding in international comparison



USA China Europe thereof Germany

Source: Zhang et al. (2021)

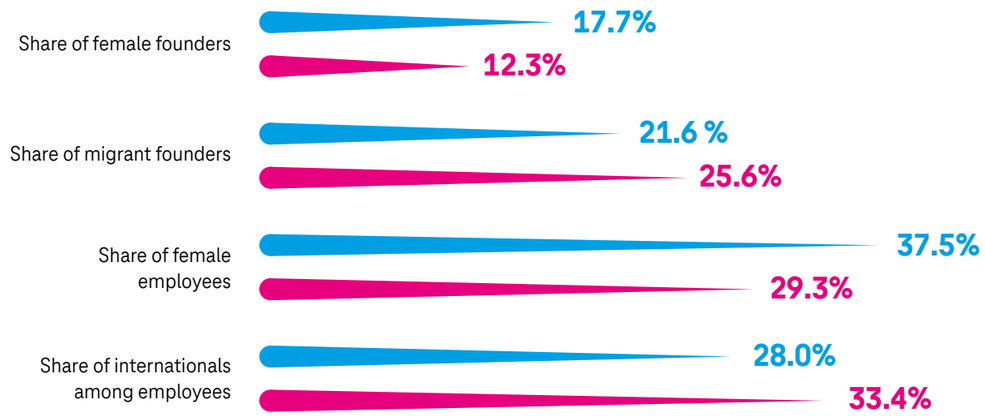
2.3. DIVERSITY IN THE AI ECOSYSTEM

Talent, founders as well as employees, is another, if not the, central resource in the ecosystem. The topic of diversity is crucial in this context: firstly, in order to have access to the full potential of motivated and qualified minds; secondly, diverse teams generate more stimuli and thus enhance the creativity of every company. The third point – and particularly true in the field of AI: algorithms make decisions that affect our lives, which is why the development of this socially relevant technology must not be left to a homogeneous group.

Reliable information is available on the percentage of people with a migration background and of women: The proportion of female and male founders with a migration background for AI startups is 26%, significantly higher than the general start-up average and roughly equivalent to the corresponding value in the general working population in Germany. Employees in AI startups are also more likely to have an international background. As a result, the AI ecosystem benefits from global networks and access to new markets and perspectives (Hirschfeld et al. 2021).
As far as the proportion of women is concerned, on the other hand, there is a need to catch up: Looking at founders as well as employees, the figures are clearly below the comparative values in the startup ecosystem, which are already very low. At the same time, the proportion of female founders has hardly increased compared with

previous years. This is due to a number of specific challenges for female founders in the startup sector, first and foremost the compatibility of family and work life. Due to persistent gender roles and greater family responsibilities, women still have less time available for their startups than men. Furthermore, there is a clear gender bias when it comes to funding and – similar to the established economy – women often lack relevant networks (Hirschfeld et al. 2020). In the AI context, these factors are further amplified since the problems of gender stereotypes and closed networks are even more pronounced in the IT and tech sector.

Figure 8: Diversity in the startup ecosystem

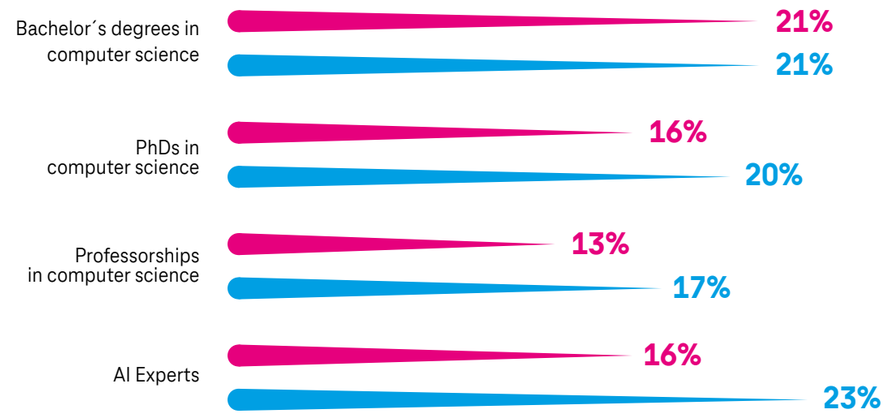


Own analysis German Startup Monitor 2021

To strengthen gender diversity in the AI ecosystem, support in the STEM subjects and in computer science is essential, while at the same time the education system as a whole must be addressed. Despite a positive trend, women still account for only 21% of bachelor's degrees in computer science in Germany, and the proportion of women with PhDs or professorships in computer science is even lower. At 23%, the above-average proportion of female and male founders with doctorates among AI startups clearly shows how important scientific expertise is in practical applications. A comparison with the US shows that more female students are pursuing academic careers there, which means that Germany should also provide more support in the academic context and has some catching-up to do when it comes to female AI specialists.

> *"If the people working on artificial intelligence tools, products and services don't reflect society (gender, race, ethnicity, physical and mental abilities) then their innovation will not have a positive impact on society and there will always be an imbalance. That is why we at Women in AI & Robotics have built up an expert community to facilitate the education and mentorship of women, from technical skills such as machine learning, Python, and cloud services to other subjects such as ethics in AI, marketing, mindfulness, etc."*
>
> ***SHEILA BELADINEJAD,** President Women in AI and Robotics*

Figure 9: Proportion of women in AI-relevant fields



Sources: German Federal Statistical Office (2021), Zhang et al. (2021), Roy (2019), World Economic Forum (2018).

3. AI IN ECONOMY AND SOCIETY

3.1. ENTREPRENEURSHIP AND DATA PROTECTION

Data is key to training decision models and developing AI solutions. This poses major challenges for AI startups that go beyond technical aspects such as data security. Currently, the main problems are legal uncertainties and restrictions, largely due to increased data protection requirements in the context of the GDPR. At the same time, regulation and far-reaching changes in the way data is handled have increased sensitivity and awareness of this topic - both among providers and customers.

Whereas the European Union has created a comprehensive regulatory framework for data protection issues and is leading the way worldwide in this field, the issue is handled very differently in the global context. In comparison with the most important technology centres, the US, China and Israel, companies in Germany have to comply with much stricter requirements. Opinions on the topic are divided among AI startups with about half seeing European data protection regulation as a competitive disadvantage on the international market.

Figure 10: Challenges in data access & privacy

35.6%

of AI startups say they have sufficient access to relevant data.

77.0%

of AI startups are calling for the state to provide more public data (open data).

52.4%

of AI startups see the European data protection regulation as a disadvantage in international competition.

Own analysis German Startup Monitor 2021

In addition to the burden of higher compliance costs, the existing regulation also leads to differences in the data economy and, most centrally, data access: Only one in three AI startups state to have sufficient access to relevant data. More than three quarters of startups are calling for improved availability and usability of public data, for example via open data initiatives or the awarding of public contracts. Just as important for AI startups are joint ventures with established companies, but the latter are often cautious due to uncertainties about data protection and especially the application of AI in sensitive areas. In this context, expertise and trust must be strengthened to facilitate data exchange (see also Section 4.3).

> ***"Data availability is a central pillar in the further development and productive use of AI, but in many areas there is still a lack of relevant data. The development of AI in Europe is already lagging behind and the current regulatory plans pose new challenges for which we do not yet have any practicable solutions. We also need to actively encourage willingness to share data – for example, by explaining to companies how AI works, what it is for and what potential it has."***
>
> ***LUKAS WAIDELICH,** Founder & CEO Cauliflower*

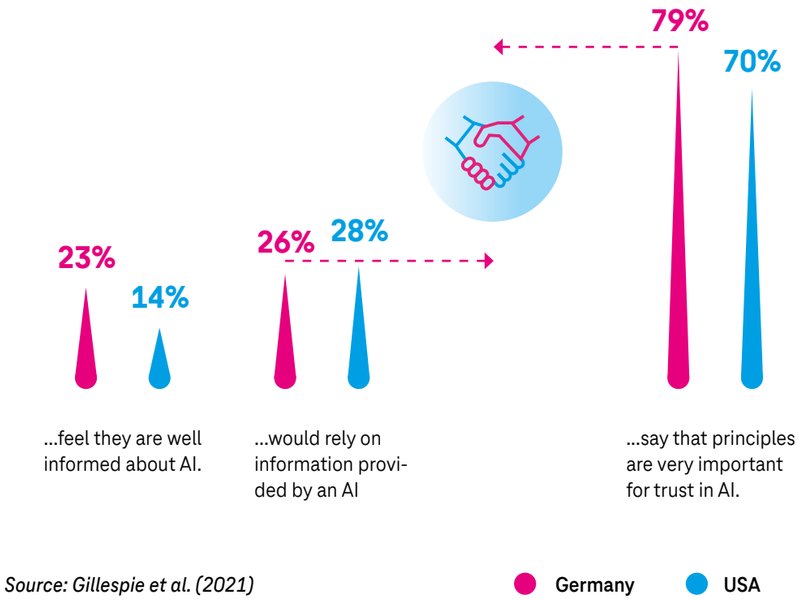
3.2. TRUST AS A PREREQUISITE FOR AI INNOVATION

Due to its novelty and complexity, AI stimulates the human imagination and consequently generates a great deal of interest among the general public. Polarised debates present AI either as cure-all remedy or as a first step towards a dystopian world. As a result, the technical possibilities and limitations often recede into the background while hopes or dangers become the central theme – extreme examples and science fiction scenarios continue to dominate the overall public impression of AI.

At the same time, the discussion highlights the importance of the ethical dimension, especially in the field of digital technologies, and reminds us that AI applications must not disregard fundamental values such as the personal rights. The growing importance of AI is also reflected in the increasing number of publications that formulate guidelines and which are supported by companies, government agencies as well as research institutions or NGOs. The wide range of people involved and the fact that such initiatives are not limited to Europe, but have also gained momentum in the US, illustrate the global dimension of this development (AI Ethics Lab 2021).

The uniting factor of the initiatives presented is the goal of building a political framework that enables business to take responsibility and thus built trust. That this is necessary for sustainable innovation in the AI sector is proven by comprehensive survey data (Gillespie et al. 2021): In both Germany and the US, only very few people feel well informed about AI and only a minority would rely on AI applications. Apart from information about the technology, ethical principles must also be firmly anchored if society – in Germany and Europe, as well as in the US – is to place its trust in AI. This is particularly important for AI startups, whose solutions are only used by customers if they feel they can rely on the technology and trust the company. Data indicate that these topics are already more firmly anchored in Germany than in the US, which could be an important USP of the ecosystem in the future.

Figure 11: Public opinion on artificial intelligence



Source: Gillespie et al. (2021)

“Trust is an important factor in the application of AI - both for experts and users alike – because there‘s a lot happening behind the scenes in AI that we can neither see nor fully explain. For example, a robotic vacuum cleaner doesn‘t scare us because it has become a likeable companion in our everyday life. Similarly, as Voice AI products start becoming a regular feature in the private space of users, gaining the trust of the user is a key success factor. For us, privacy by design has been a core principle from the very beginning of the development of the Magenta Voice Assistant. We can only be successful if our customers trust our products.”

***REGHU RAM THANUMALAYAN**, Senior Vice President, Magenta Voice Programme, Deutsche Telekom*

“In recent years, AI applications have reached a level, that, technically speaking, offers unprecedented possibilities. They are already being applied in many areas of everyday life, often being unnoticed. Yet in the public debate, there is a lot of hype surrounding artificial intelligence, as we all know from science fiction films where it often takes on human form as robots. In public, experts also often speak in abbreviated terms about AI instead of stating specific use-cases. Although many people are already very competent users of digital solutions, they often lack an understanding of the underlying mechanisms. This is also due to the fact that currently in Germany, the education system has failed to provide an understanding concerning our digital life – from the Internet to programming or how machine learning works. Most people are not familiar with algorithmic thinking. A wide variety of measures are necessary here – be it school lessons in digital theory or open online courses like Elements of AI.”

***LENA-SOPHIE MÜLLER**, Managing Director Initiative D21*

3.3. REGULATION AS A FACTOR IN THE AI ECOSYSTEM

The German AI ecosystem and startups are characterised by a high sensitivity to ethical issues. The vast majority of AI startups are aware of their own impact and responsibility and see ethical aspects as a key component in the development of AI in their company. This is an important basis for developing Germany as an AI location that pioneers AI based on ethical principles and trust. Central to the practical implementation of this concept is the regulation of AI: Just under half of all AI startups see this as a possible USP in international competition. This mixed picture largely stems from the uncertainty that still exists with regard to the current status of regulation.

Figure 12: Approval of German AI startups on topics of ethics and regulation

88.3%

AI startups must be aware of their societal importance and associated responsibility.

81.3%

Ethical issues (e.g. discrimination, transparency) should play a role in the development of AI.

46.6%

European AI regulation creates trust and can become a USP in international competition.

Own analysis German Startup Monitor 2021

The draft legislation on AI presented by the European Commission in April 2021 was received positively in principle, but still requires some key adjustments in terms of its application. The core idea of the law is not to impose additional rules on AI across the board, but to define high-risk areas in need of specific requirements as detailed as possible. This would mean that many uncritical AI applications, for example in the field of Industry 4.0, where work is mainly performed using machine data, can remain unaffected. Alongside "unacceptable risk" applications, such as social scoring, which are to be banned altogether, additional rules will be introduced for "high risk" solutions, such as in critical infrastructures, education or law enforcement. Such rules could be enhanced requirements concerning data quality, keeping records and ensuring the traceability of decisions, mandatory compliance assessments and regulatory audits.

> *"The discourse on ethical issues in AI has evolved constructively in recent years: It is focusing less on abstract decision-making problems or threats of a superintelligence but much more on practical opportunities as well as risks regarding the protection of democratic rights and norms concerning specific use cases. What is considered fair and ethical is highly contextual, and not every AI system needs to be regulated in the same way. The risk-based approach in the current draft of the European AI regulation is therefore the right way forward. What is important now is that the decision on which use cases are banned or placed in the highest risk category is based on a participatory process involving civil society."*
>
> ***CARLA HUSTEDT,** Director Centre for Digital Society at the Mercator Foundation*

For AI startups, the draft law poses two main challenges: Firstly, due to the vaguely formulated definition of the regulated applications, many are uncertain whether their own company is affected. In addition to the scope for interpretation, even a slight expansion of the definition may lead to many additional fields being regulated. Secondly, startups do not yet know how they are to comply with the requirements formulated in the law, for example in view of the immense amounts of data processed. In the next stages, the AI legislation must reduce uncertainties, consider practical feasibility, and make room for experimentation – a regulatory sandbox framework would be a good tool here. In summary, the new framework conditions must promote innovation in the AI sector, because only a strong German and European AI ecosystem can actively shape values and guidelines.

> *"As a medical technology provider, our AI systems already have to undergo strict certification procedures in which the function and performance are checked thoroughly. The EU Commission's new draft for a legal framework in the field of AI could then impose twofold regulations on us. In addition to the extra work involved, this would also create uncertainty among the many stakeholders – manufacturers, auditors, and users (doctors, patients) alike. In general, what we need is far more information about what AI actually is and what the possibilities and dangers are – especially in sensitive fields like the healthcare sector."*
>
> ***ELLA MARIA KADAS,** Founder and CEO nocturne*

> *"AI is already regulated in some sectors as a system component, for example in mechanical engineering – additional requirements specifically for the AI component mean double regulation, and that creates new uncertainties instead of the necessary legal certainty. Applications such as social scoring, which are not compatible with our European values, should not be regulated based on their technology but with respect to their field of application: Social scoring is, after all, also unacceptable when done with pen and paper."*
>
> ***RONNIE VUINE,** Founder and CEO micropsi industries*

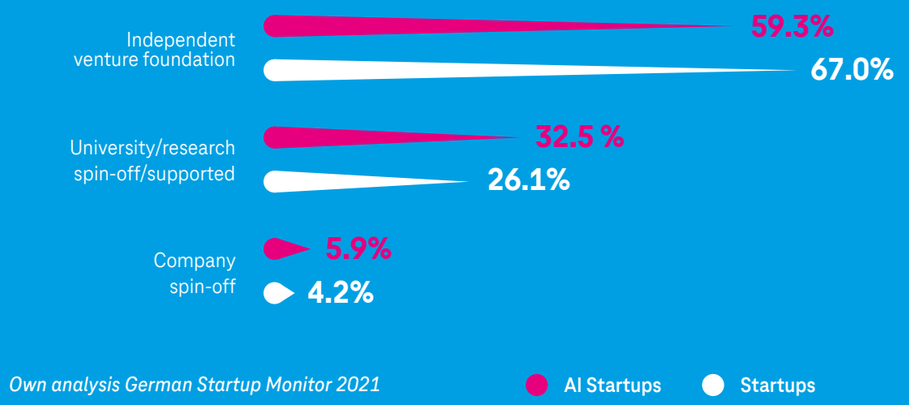
4. POTENTIALS IN RESEARCH AND THE ESTABLISHED ECONOMY

4.1. R&D STRENGTH AND STARTUP SUPPORT AS A BASIS FOR AI STARTUPS

A lot of applications developed by AI startups depend on highly specialised knowledge and operate at the interface of cutting-edge research and entrepreneurial practice: AI startups therefore engage in very close exchange with universities as well as other research institutions. 72% of AI startups are involved in some form of cooperation with scientific institutions.

Support programmes such as EXIST play an important role in the early phase, but long-term success also requires exchange in later phases. For AI startups and their technological development, contact with the academic world is therefore a key success factor. At the same time, universities and research institutions act as enablers for many startups – especially in the case of AI: almost a third of AI startups stem from this environment.

Figure 13: Startups emerging from universities and research institutes



Own analysis German Startup Monitor 2021

Another positive aspect to be highlighted is that the interface between science and startups is becoming more relevant for the AI ecosystem: Among the AI startups in the seed stage, the value of startups emerging from a research or university environment is already 43% and thus significantly higher than in the AI sector as a whole (33%). At the same time, only 34% of all AI startups emerging from a research or university environment are spin-offs from research projects. This makes it all the more important that the well-established funding schemes available in the early stages are supplemented by more offers for later stages – university-based startup programmes and startup centres must cover the path from idea generation through the first (VC) funding to the growth stage if they are to have an overall effect. Such an ecosystem embedded between science and business grows with its founders: This is demonstrated by developments around TU Munich over the past 20 years, where a large number of successful new companies have emerged – including Celonis, now the most valuable German startup.

Figure 14: The challenge of changing roles (science → business)

65.9%

AI Startups

55.9%

Spin-offs in general

Own analysis German Startup Monitor 2021

In many areas, funding for spin-offs has increased in recent years and there is a much wider range of relevant support services. This is important since spin-offs are faced with several specific problems: In addition to regulatory and bureaucratic hurdles, the main issues are related to competencies and mindset, especially regarding the change of the individual's role from scientist to entrepreneur. These difficulties are particularly pronounced among AI founders who started off in academia. Comprehensive startup support and proximity to the business world is therefore particularly important for the successful development of startup ecosystems.

USE CASE : UNTERNEHMERTUM

A BRIDGE BETWEEN RESEARCH AND THE MARKET

With more than 50 startups per year, the UnternehmerTUM startup centre at TU Munich is a best practice when it comes to university-based startup support programs. Established in 2002 by Susanne Klatten and Prof. Dr. Helmut Schönenberger, who is still the managing director, the centre was set up outside the university and administrative structure. It stands out for its entrepreneurial leadership and openness to cooperation with the established business community. The centre modelled itself on the innovation ecosystem around Stanford University where the close exchange between university, companies and investors has produced many of today's most important startups in the digital economy.

Well-known startups such as Celonis, KONUX and TWAICE bear witness to the successful work of UnternehmerTUM. The centre currently has over 300 employees who advise startups on technology and business model development and support established companies with innovation and digitalisation – the synergy effects are obvious and are promoted in cooperation projects. This connection is essential in the field of AI and is strengthened by the appliedAI Initiative which aims to explain and promote AI application among established companies and in doing so draws on the expertise and innovations of the UnternehmerTUM ecosystem. Conversely, AI startups learn about the needs of potential customers and are made visible throughout Germany via the initiative's AI map.

A striking feature of UnternehmerTUM is that founders are offered help from the first business plan through to the growth phase. In addition to startup consulting and a maker and co-working space, the centre also provides an early-stage investor, UVC Partners, to support startups during the important first steps on the market. UnternehmerTUM offers more than many other startup support centres and thus illustrates the vast potential in this field. The most important difference between UnternehmerTUM and the many institutions that are more strongly integrated into university structures is that networking with the established industry as cooperation partners and customers, as well as with investors, is actively pursued. The idea is to bring together SMEs and industry with creative minds, especially those with a research background, and to support startups with initiate cooperation and customer relationships.

“Support for startups at universities has improved significantly in recent years, including a lot of new chairs in entrepreneurship and startup centres. However, these initiatives only have an economic and social impact, if the startups develop into real businesses. For this to happen, we need startup supporters with an entrepreneurial mindset and good contacts to investors, established companies and other drivers of the startup ecosystem. With these prerequisites they can act as essential link who can help get spin-offs out of the academic world and connect them with the market.”

***PROF. DR. HELMUT SCHÖNENBERGER,** Vice President Entrepreneurship TU Munich and CEO UnternehmerTUM*

4.2. STRENGTHENING RESEARCH TRANSFER AND USING NETWORKS

Germany has no need to hide internationally when it comes to research in AI: With its long tradition in AI-related disciplines, the benefits of its academic breadth and excellence are still present (Seitz et al. 2020). In other countries, however, this strong foundation is put into entrepreneurial practice much more frequently: Besides smaller digital pioneer states such as Israel, Singapore and Estonia, AI-related entrepreneurial activity in the US is about three times as high as in Germany, with 14 AI startups founded per million inhabitants between 2016 and 2020. At the same time, a strong development in the technology sector also benefits the scientific world in countries with high entrepreneurial activity since business applications also play an increasingly important role in research when it comes to proposals and third-party funded projects.

“The best startups have founding teams that combine an inventor DNA with an understanding of entrepreneurship. With Earlybird UNI-X we set up a new seed fund to get even closer to universities and identify promising startups in this field at a much earlier stage. We see great opportunities here for Germany to integrate its strong research landscape better into entrepreneurial practice and to leverage the enormous potential of spin-offs.”

***MICHAEL SCHMITT,** Earlybird UNI-X Partner*

Figure 15: AI startups established (2016–2020) per 1 million inhabitants incl. rank

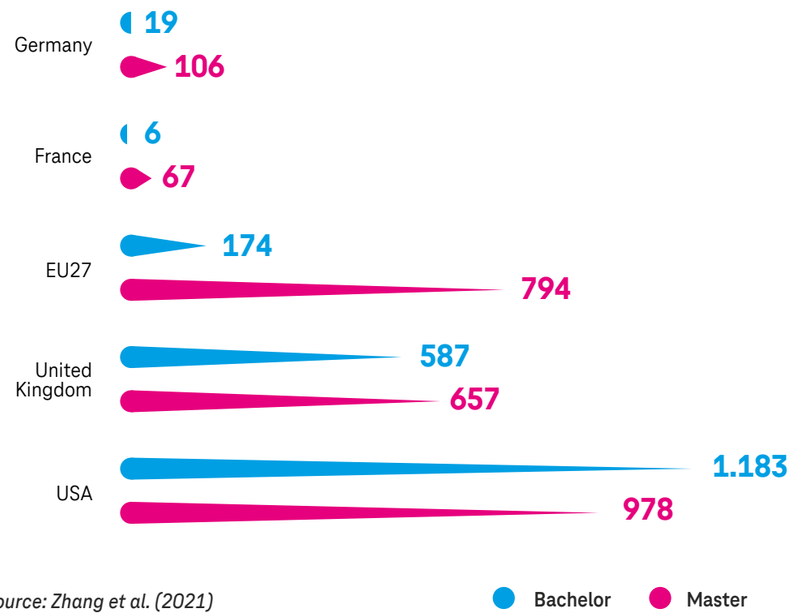
1.	Israel:	60	
2.	Singapore:	53	
3.	Estonia:	40	
4.	UK:	22	
7.	USA:	14	2.8 x
17.	Germany:	5	
18.	France:	5	

Source: Zhang et al. (2021)

The expansion of AI education and research is a key component in strengthening startup dynamics. The US and the UK, which both score well in terms of AI-related entrepreneurial activity, are very positive examples. In the US, there are significantly more dedicated AI degrees and in the UK alone almost as many as in all EU countries combined. Even if specialised programs are not the only way to build up AI expertise, they are an important indicator of the relevance of the topic in science and politics. With 19 bachelor and 106 master’s degree programmes focusing on AI to date, Germany – like France – performs poorly in an international comparison. Not only does this mean a lack of potential founders, but also a lack of specialists for AI startups.

> *Proximity to the academic world is part of our company DNA at Celonis – starting with our first project when we were still students right up to our Academic Alliance team today. We collaborate with research institutions on an ongoing basis to test theoretical approaches in practice and get them ready for the market quickly. Not every project is a success, but cooperation with the academic world is of high strategic importance to us – to help us remain innovative, and also to attract the best talent to our company."*
>
> ***BASTIAN NOMINACHER,** Co-CEO & Co-Founder Celonis*

Figure 16: AI study programmes in selected countries



Source: Zhang et al. (2021)

Academia is very important for training employees in the AI sector – the same is true when it comes to founders. Universities also have a networking effect that should not be underestimated. 41% of all AI founders say that they met at least one founding team member at university. Apart from founding teams that emerge out of random encounters, universities also have the opportunity to specifically promote team constellations where technological and business expertise complement one another, thus facilitating the transfer into practice.

Figure 17: Universities as a place for team formation

Own analysis German Startup Monitor 2021

4.3. SYNERGIES WITH THE ESTABLISHED ECONOMY

Considerable potential for the German AI ecosystem can still be leveraged not only in the academic world, but also through cooperation between startups and the established economy. 72% of all AI startups are already collaborating in various forms and intensity with established companies and generate 77% of their revenues with B2B customers, a significantly higher share than startups in general (69%). In addition to acquiring new customers and building up references, cooperation projects offer AI startups the opportunity to gain access to valuable data sources. Almost two-thirds of AI startups state that it would be useful to them if established companies made their data more accessible. There are some real win-win situations here: Established companies are often unaware of the potential of their data and AI startups depend on high-quality data sets to develop their ideas further. A close alliance between industry and startups could be a European way to strengthen the AI ecosystem in international competition.

> *Compared with other countries, there are a lot of large companies in Germany that play a leading role in the application of AI in production and actively address the topic with the appropriate resources. When it comes to SMEs, however, the picture is quite different. Digitalisation projects are often postponed due to a*

lack of capacity – and sometimes the benefits of AI solutions are not yet recognised. Concrete projects designed to strengthen the cooperation between the established economy, startups and research centres are very important here."

***PROF. DR. MARCO HUBER,** Professor of Cognitive Production Systems at the University of Stuttgart and Head of the Centre for Cyber Cognitive Intelligence (CCI) and Head of the Image and Signal Processing Department at Fraunhofer IPA*

"Our established economy – especially in industry – has a lot of unused data, but if we don't seize this opportunity soon, we will lose a competitive advantage. We need to talk less about AI projects and get them off the ground more quickly. Established companies need an open culture that thinks outside the box and where mistakes are allowed. They also need the competence to decide whether to develop AI solutions themselves or buy them in. To get ahead, we need spaces for collaboration where science, industry and startups can meet up and work together on AI solutions – with our AI Campus in Berlin we have created just that place."

***NICOLE BÜTTNER,** Co-Founder & CEO Merantix Labs*

Figure 18: Demand for better access to data from established companies

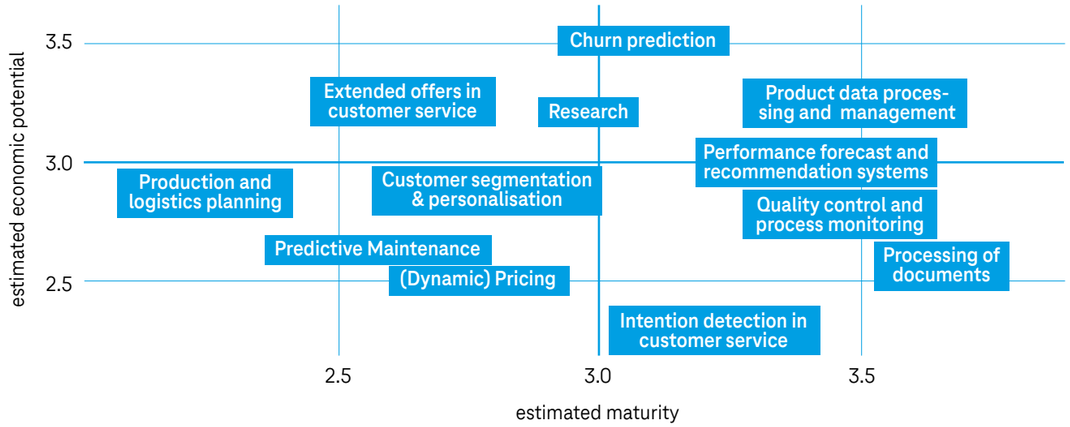
Own analysis German Startup Monitor 2021

More cooperation between AI startups and established companies would be an important stimulus to innovation in the German economy: In 2019, just 5.8% of all German companies used AI solutions within their organisation (Federal Ministry for Economic Affairs and Energy 2020). The basic prerequisite for successful collaboration is for companies to be able to identify the right AI startups for their projects. However, due to a lack of resources and AI expertise as well as the increasing number of startups, this is a huge challenge for companies – especially in the SME sector. Initiatives are needed here that build bridges between companies and AI providers – such as the collaborative research project "What can AI do for me?" (Seitz et al. 2021).

The more than 90 use cases identified within the project demonstrate the broad spectrum of AI applications, which differ significantly in their economic potential as well as their degree of maturity. While the automated processing of documents, for example, is already highly developed, it scores lower on the commercial scale. Other applications, such as in customer service, have great economic potential but still a significantly lower degree of maturity. Looking at cooperation projects in Germany, the most relevant use cases are to be found in the industrial sector: Applications in the fields of quality and process monitoring as well as in product data have already reached a very high level. In contrast, there is a need for further development in more complex applications such as predictive maintenance or production planning. The collaboration between industry – a cornerstone of the German economy – and AI startups offers a new path for innovation and growth and is becoming increasingly relevant as a competitive factor.

Figure 19: Expert assessment of AI use cases in German companies

OVERVIEW USE CASE CLUSTERS
How do experts assess the AI use cases of German companies



Source: Seitz et al. (2021)

5. DIGITAL SOVEREIGNTY

The field of AI shows paradigmatically that digital innovations are not only of economic importance but also have an enormous political significance and that economy and society are closely linked here. From hardware to data infrastructure or large AI models such as GPT-3 – the market leaders in AI are to be found in the US and China, while European companies are in danger of being left behind in an increasing number of fields. Given the social relevance as well as the economic potential of the technology, this development calls our digital sovereignty into question and underlines the importance of promoting AI innovations.

Against this backdrop, the upcoming AI regulation process will be a balancing act: On the one hand, the USP of European AI – responsibility – must be consolidated in order to promote trust in the technology and make its quality visible. On the other hand, legal uncertainties and new requirements, which have a greater impact on younger companies in particular, must not be allowed to slow down innovation or cause it to take place elsewhere. This applies not only to AI startups, but also to the use of AI in the broader economy, where progress in digitalisation is increasingly shaped by AI. Without strong companies we will not be able to shape global development or implement our ideas of responsible AI in practice.

> *If we want to be successful in the field of AI in general and not just in niches, we need to start making real progress in Europe now. When it comes to hardware, data infrastructure, AI-as-a-service and, above all, AI models such as GPT-3, American and Chinese companies are way ahead of us. Initiatives such as GAIA-X are crucial to improving the infrastructure for AI innovation. With Large European AI Models (LEAM), we are developing a European lighthouse project to strengthen large European AI models and increase our competitiveness in this field.“*
>
> ***JÖRG BIENERT,** Chairman German AI Association*

“The US and also China are way ahead of Europe when it comes to scaling AI-driven and data-based business models – it is essential that we catch up. Otherwise, we end up as a bystander merely observing the current shifts in the balance of power, which will undoubtedly be escalated by the big tech companies and AI. Companies and startups in Europe should concentrate on putting people and values at the centre of their approach to developing AI. This way, they can turn responsibility into an USP and work on a strong basis of trust that will differentiate them from their competitors. Trust is the most important currency in the cognitive age and therefore the foundation for growth.”

***OLAF J GROTH**, PhD, CEO Cambrian.ai, Professor for Global Strategy, Innovation, Economics & Futures at HULT International Business School and UC Berkeley Haas School of Business*

“We have not lost our sovereignty in the field of AI, we never had it. Today, algorithms make decisions every day that affect our lives but we cannot understand them. That is why we need to promote technology that complies with our European values and guidelines. Open source applications offer great opportunities here – especially for startups. This is because transparency in this area creates trust and makes applications comprehensible without requiring a great effort from the companies themselves.”

***RAFAEL LAGUNA DE LA VERA**, Director Federal Agency for Disruptive Innovation*

“Europe has plenty to offer in the field of AI – we need to make this more visible! Because so far, it’s generally not the European companies that are entrusted with the big projects. But if we don‘t give our AI companies the chance to prove themselves in practice and to move forward – especially through public contracts and access to large data sets – then we will be left behind. The issue of digital sovereignty is also high on the agenda of the French EU Council Presidency.”

***GAËLLE PINSON**, CEO Hub France IA*

It is essential for Germany to harness its research strength in the field of AI and to translate it much more strongly into commercial applications. Most importantly, AI education must be advanced and the diversity of the next generation of developers given targeted support. In view of problems concerning access to data and investments, cooperation with the established economy should be intensified so that startups can get their first projects up and running, but also to bring established companies and AI technology closer together in order to strengthen competencies. The goal must be to take advantage of upcoming technological advances through a close alliance between research, industry and startups in Germany and thus to push forward “AI Made in Germany” as a seal of innovation and responsibility.

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hubraum offers various innovation programs and seed financing as well as access to infrastructure and future technology provided by Deutsche Telekom. Startups can also benefit from co-working space, mentoring, networking events and connections to Deutsche Telekom's business units.

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PUBLISHER AND AUTHORS

Startups are the driving economic force of the future – visionary founders putting great ideas into practice. As the representative and voice of startups in Germany, the German Startups Association has been committed to a founder-friendly environment since 2012 and currently represents more than 1,200 members. Within its network, the Startups Association enables an equal exchange between innovative young companies, established businesses and the political sphere. This report was realized in cooperation with the German AI Association and the Institute for Applied Artificial Intelligence.

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