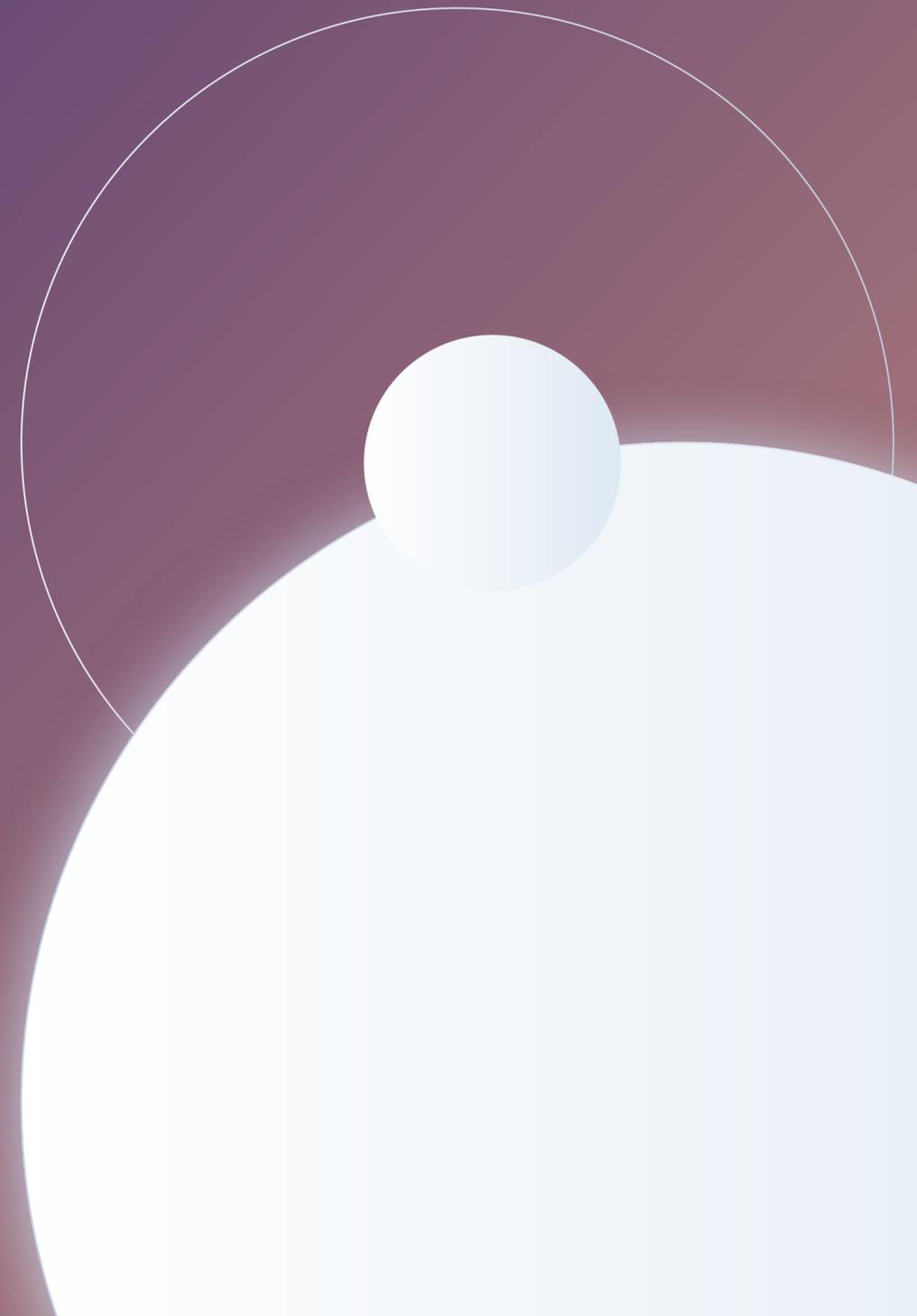


TheGlobalCTOSurvey. × STXNEXT
python powerhouse

SURVEY RESULTS & INSIGHTS

The Global CTO Survey 2021 Report



As we adjust to the “new normal,” now is the time to ask: what does the future hold for CTOs?

As the global economic recovery continues, the year 2021 feels much more optimistic than its predecessor.

Changes have been felt strongly in the IT and technology industries where recent circumstances have accelerated progress and pushed tech leaders to reexamine the direction they are heading.

Now is the time to look to the future. And understanding how other CTOs are tackling current issues is more crucial than ever. We're fortunate to have received insight from over 500 CTOs worldwide.

What technologies have CTOs chosen for their tech stack?

What measures are being taken to protect data and IP?

What are the biggest challenges for tech leaders at the moment?

How are CTOs helping themselves and their teams grow?

The Global CTO Survey Report 2021 has been created to help you find out answers to these questions and many more, helping you make the right decisions for yourself and your team.

The Global CTO Survey Report 2021

Response to the second annual Global CTO Survey has been phenomenal. Following the success of the 2020 survey, the number of respondents for this year's survey has more than doubled with more than 500 CTOs from around the world contributing their time and sharing insights. This time around we included more questions on technology, current trends, security, management, and more—which means we have been able to build up a clearer picture of what life is like for a CTO in 2021.

70+

Questions in the survey

From how CTOs got where they are today to technology, leadership, and challenges

500+

Total responses

From CTOs worldwide

4

Continents

Europe, North America,
Asia, and Oceania

Thank you to everyone who
participated in the survey

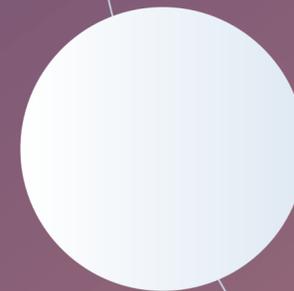
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01

Career path

Our CTOs' journey so far



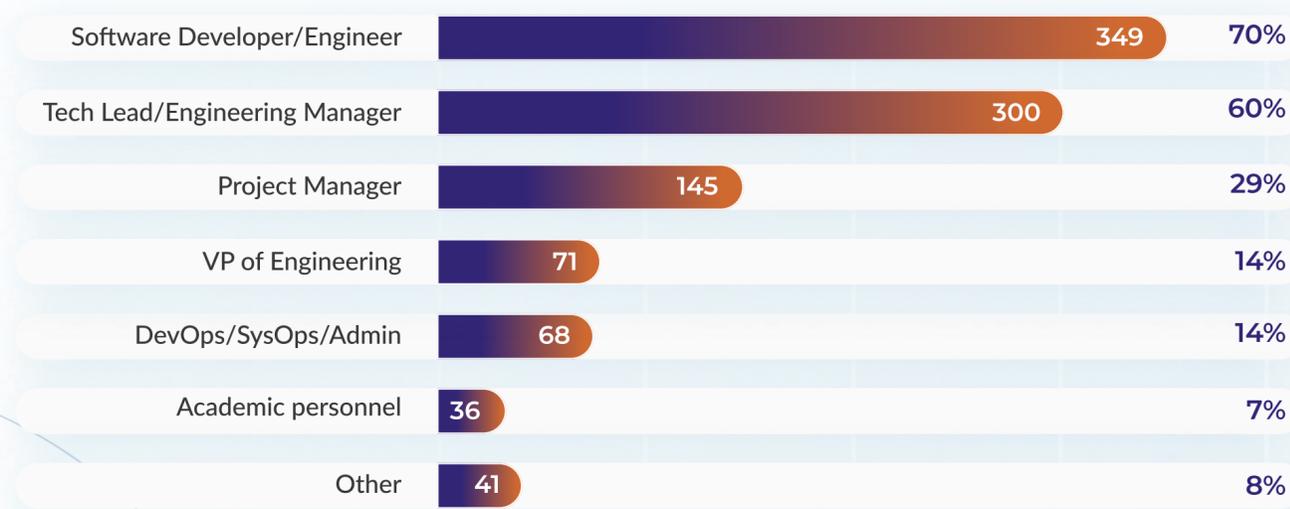
How long does it take to become a CTO—and how do you get there?

The routes to becoming a CTO are varied, but there are some well-established paths. 70% of respondents had previously worked as a **software developer/engineer**. Surprisingly, even though a **VP of Engineering** position can be a natural progression on the road towards CTO, only 14% of our respondents held a VP of Engineering role before becoming CTO.

For the majority of respondents, becoming a CTO took between **5 and 15 years**—but 20% were lucky and/or resourceful enough to achieve a CTO position in less than 5 years.

CTOs' skills in programming come from a combination of **formal education** and more casual **self-improvement**. Around two-thirds of respondents learned to program at university; 63% honed their skills through tinkering.

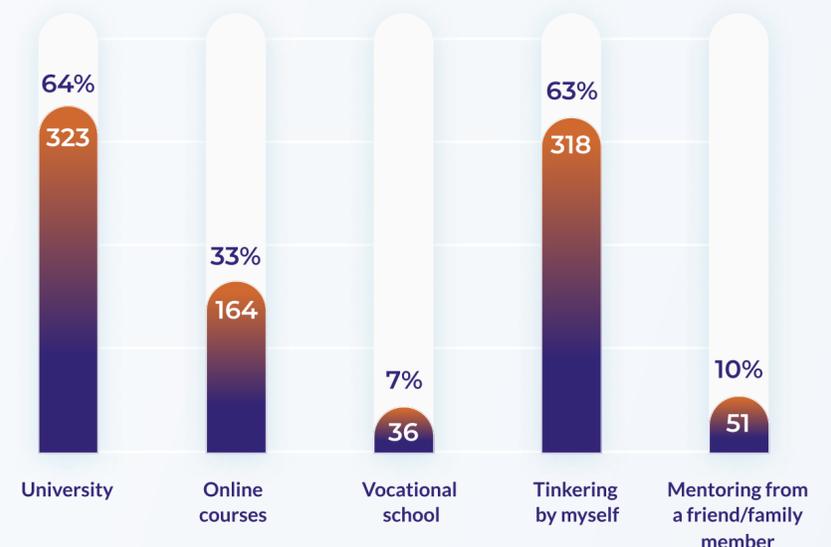
What were your previous roles?



From the beginning of your career, how many years did it take you to become a CTO?

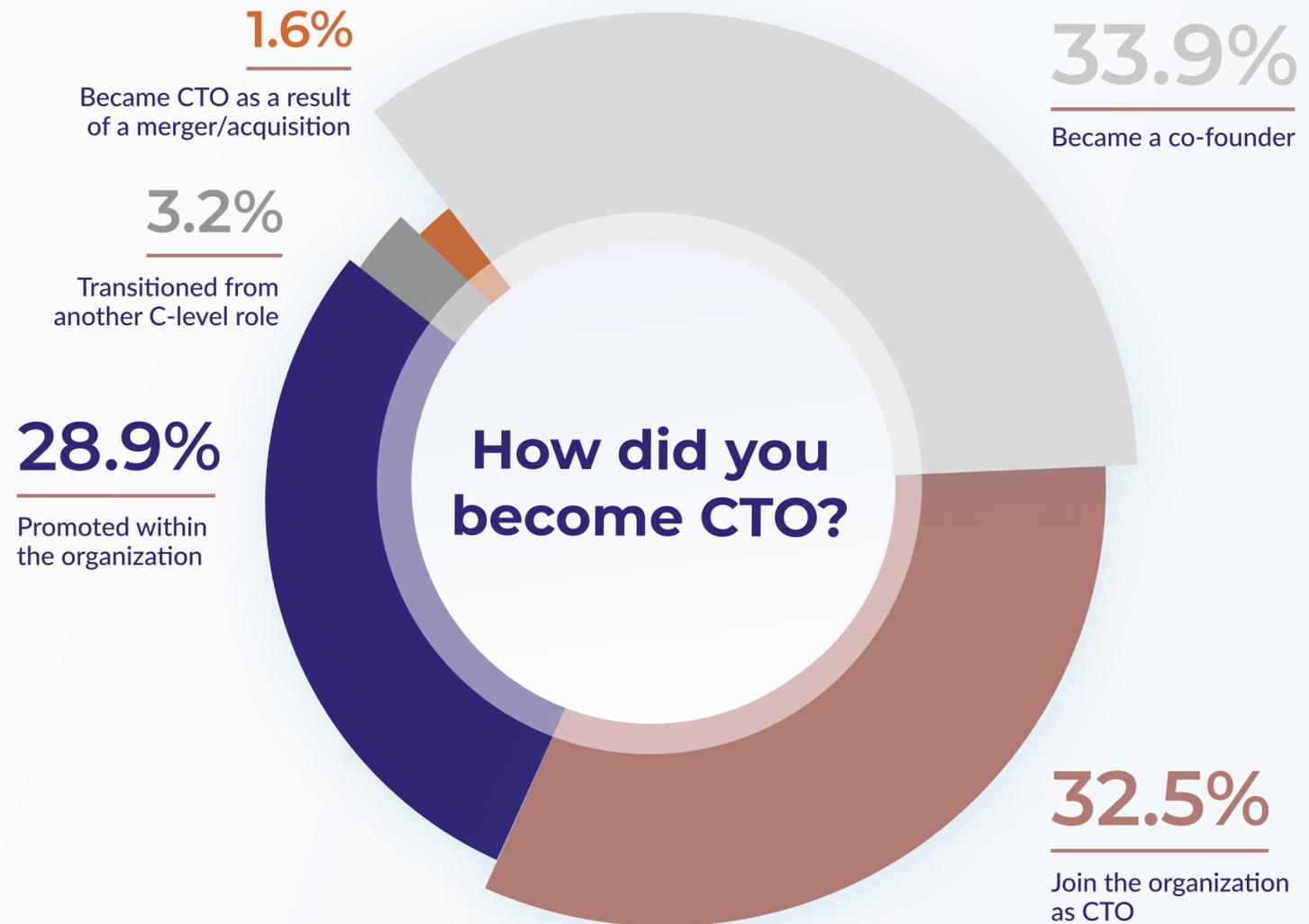


How did you learn programming?



Planning to become a CTO? External opportunities may be the key

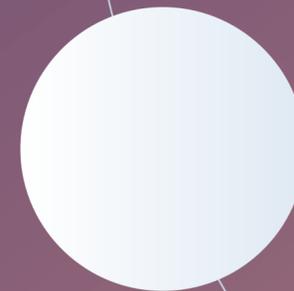
If you are looking to become a CTO in the future be prepared to explore opportunities outside your current organization. Just under a third of our survey respondents (28.9%) were promoted to CTO within their company; whereas two-thirds (66.4%) of respondents either became a co-founder of a new company or joined another organization as a CTO. Less than 5% of respondents became CTO as a result of a merger/acquisition or by transitioning from another C-level role.



02

Tech stack

The languages, frameworks,
and tools that CTOs are using
to build their software



JavaScript named as core programming language alongside Python, PHP, and Java

When it comes to programming languages found in the tech stack of the CTOs' teams, it's the same big hitters that occupy the top five positions as last year (with PHP overtaking Java to take third place).

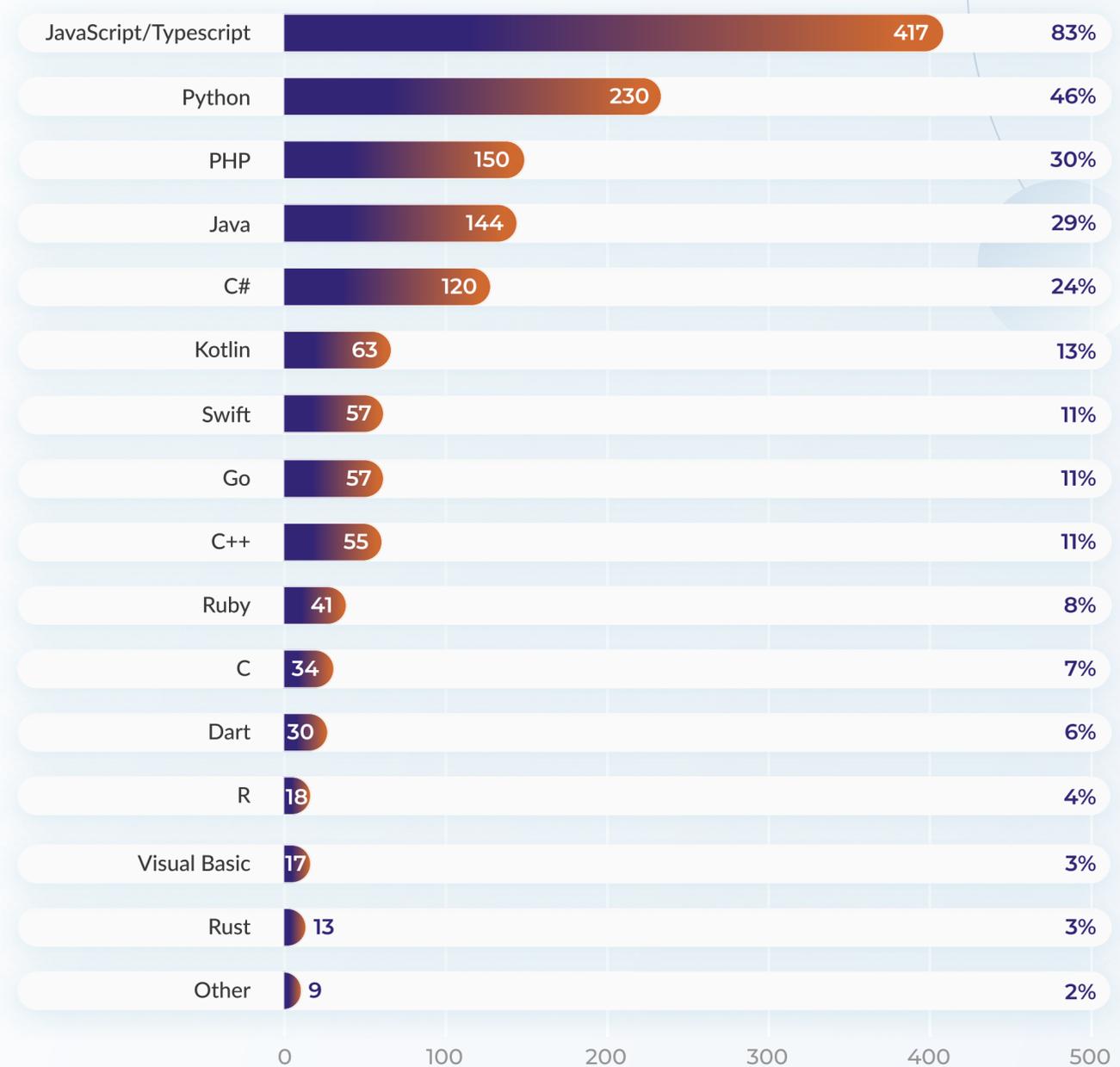
JavaScript (or TypeScript) was named as the **most commonly-used** programming language with CTOs in this survey; **83%** of respondents tell us that it is a primary language in their tech stacks. JavaScript has gained widespread popularity as a language that's supported by all modern browsers that can enhance the frontend.

In second place for a second year running is **Python**. Popular with CTOs and developers alike due to its intuitive nature, extensive libraries, and time-to-market speed, Python is present in **46.8%** of our respondents' tech stacks.

Respondents to the survey are not tied to one language which is unsurprising due to the difference in functions and strengths different languages offer. CTOs' teams used an average of **3 languages** in their tech stack.

There has been a jump in popularity for Kotlin and Swift; these two languages have moved from places 10 and 11 respectively in 2020's survey to the sixth and seventh positions in 2021's survey.

What are your teams' primary programming languages?



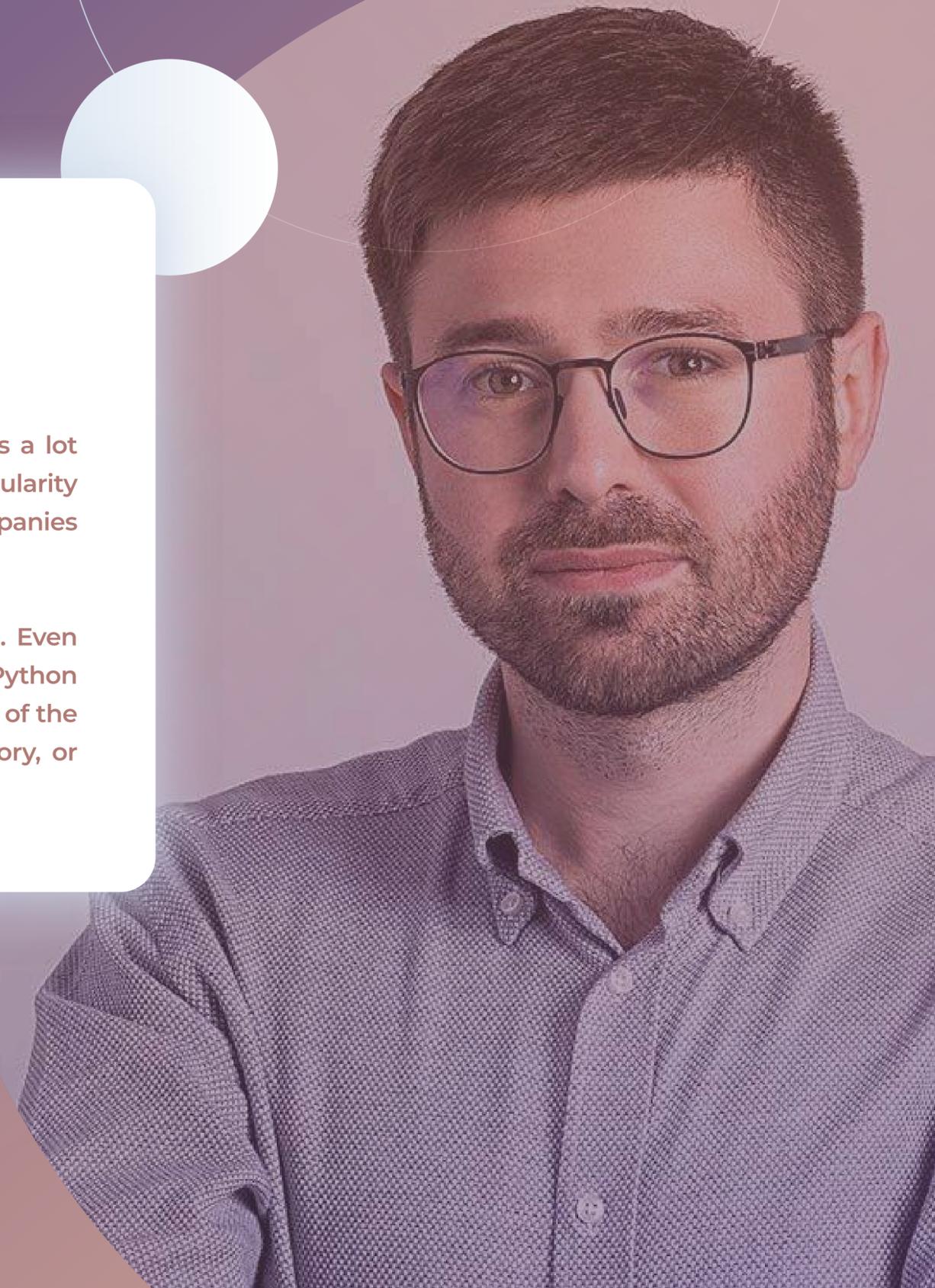
Expert commentary

Marcin Zabawa

DIRECTOR OF CORE SERVICES @ STX NEXT

The top three languages are script languages used for the web. This tells us a lot about the current trends. The fact that these languages are topping the popularity chart is due to the demand: the internet is widely used and more IT companies create web products than, for instance, drone software.

What attracted my attention is the fact that Rust got only 2.6% of the vote. Even though developers like it, the language is not widely used by businesses. Python used to be programmers' favorite at the beginning, too, and then became one of the most popular languages globally. Perhaps Rust will follow the same trajectory, or maybe it's just a fad?



Combined programming languages: JavaScript is a mainstay, complemented by Python

We've learned that CTOs' teams use an average of 3 programming languages across various projects within their organization—but what are those languages?

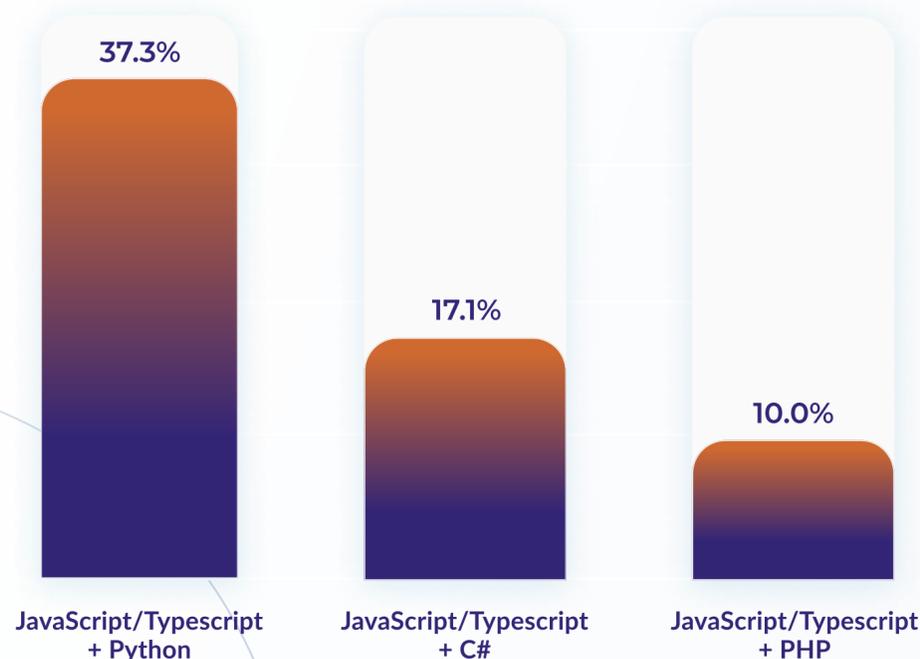
The most popular pairs of languages (languages used together within one CTO's organization, which may have been complemented by other additional languages) were:

JavaScript/Typescript + Python → 37.3%

JavaScript/Typescript + C# → 17.1%

JavaScript/Typescript + PHP → 10.0%

The most popular pairs of languages



The most popular combinations of three languages were:

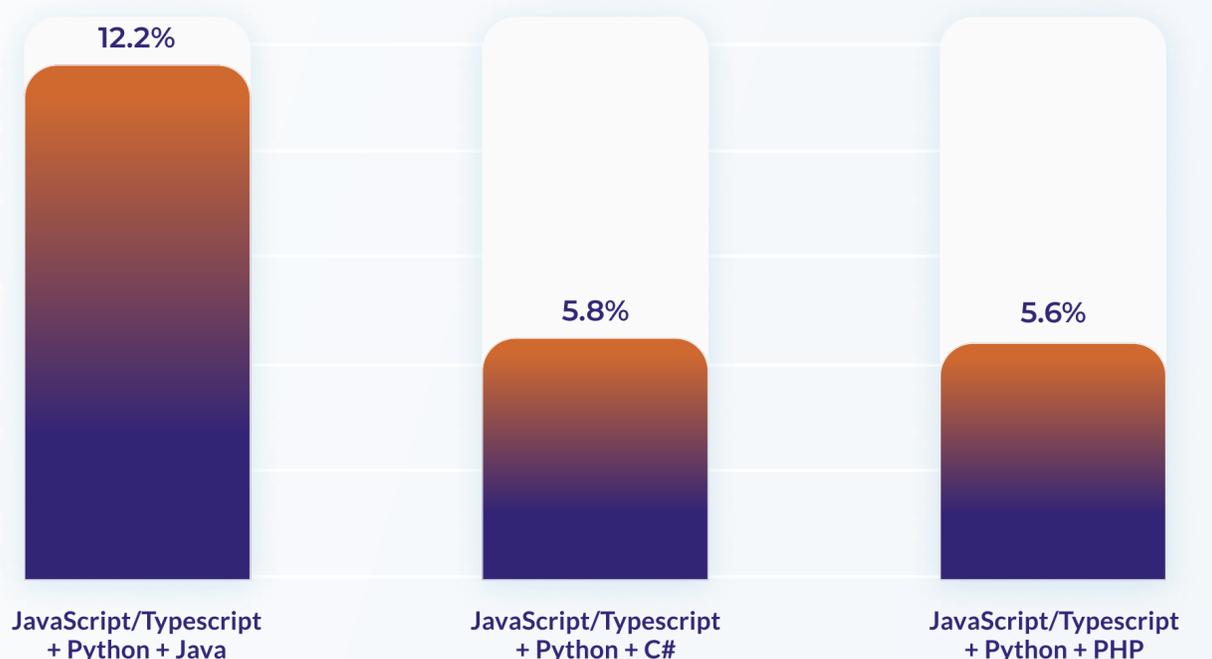
JavaScript/Typescript + Python + JAVA → 12.2%

JavaScript/Typescript + Python + C# → 5.8%

JavaScript/Typescript + Python + PHP → 5.6%

The conclusions are pretty clear: it's hard to imagine a modern tech stack without JavaScript, which is often combined with other popular languages. Python is a natural second choice, almost twice as popular as the runner-up C# and three times as popular as JavaScript + PHP.

The most popular combinations of three languages

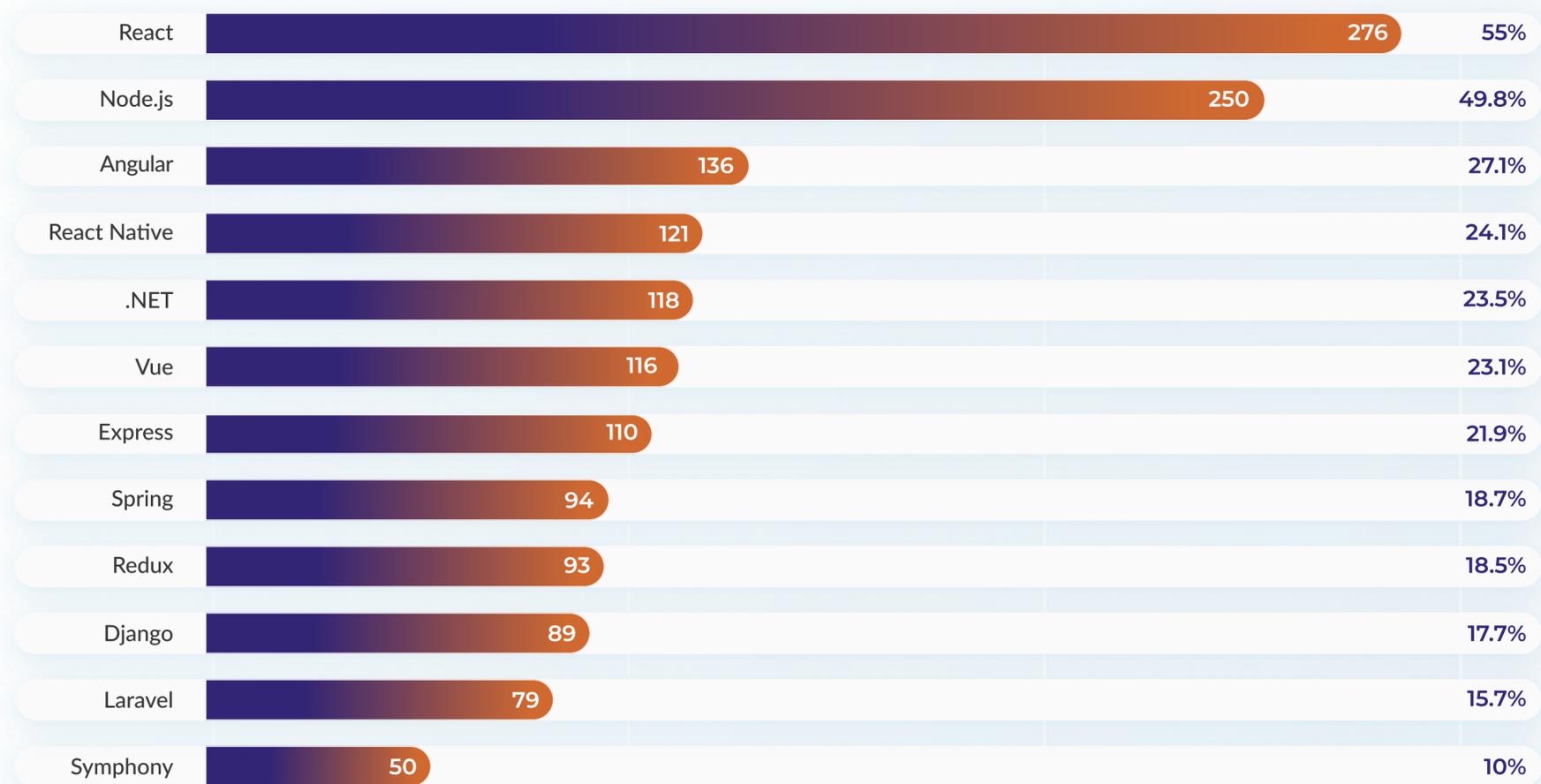


JavaScript technologies are the go-to choice for dev teams

JavaScript allows developers to produce universal solutions that are available on all platforms. As a result, the top technologies used by our respondents' teams are all based on JavaScript. The widespread use of JavaScript technologies is directly linked to the popularity of the language itself.

Unlike in the past, these days tech stack seems to be dictated more by the choice of a particular framework rather than a language. And as JavaScript happens to be the most fragmented language, it seems natural that its frameworks and libraries play a central role in many companies' tech stacks.

What programming technologies do your teams use?



Expert commentary

Cezary Dynak

HEAD OF NODE.JS @ STX NEXT

It's fascinating to observe how Node.js took the path from geeky experiment to CTOs' technology of choice for the backend. It helps to reduce the costs of development and is also easier to learn for teams. As there is no escape from JavaScript and TypeScript for creating user interfaces, there's a strong business case for covering both the frontend and the backend using those languages. I wonder what the future will bring for alternative runtimes like Deno and Cloudflare Workers.

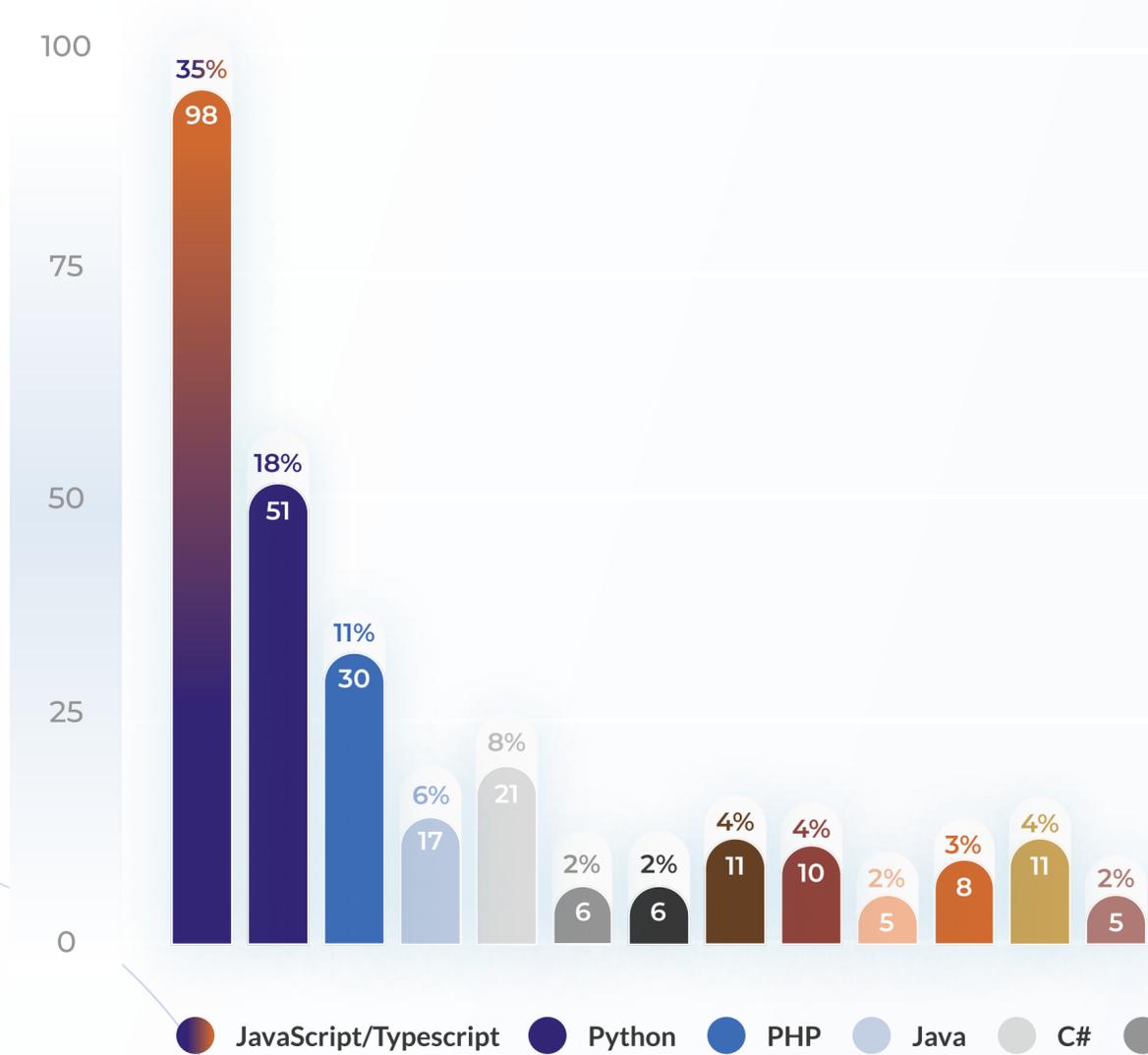


Small companies bet on JavaScript

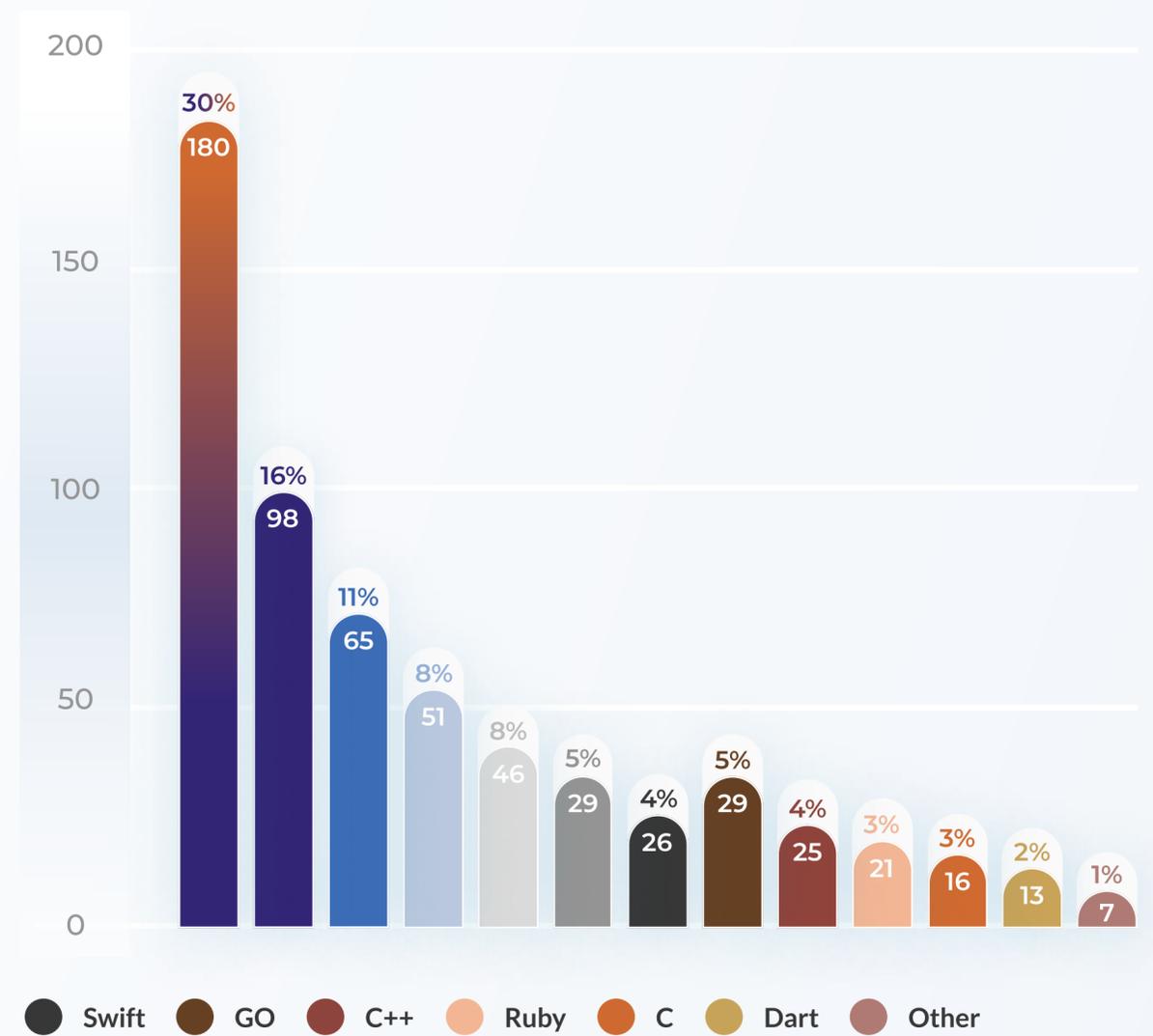
In companies sized 1-10 and 11-50 which took part in our survey, JavaScript is unquestionably the most commonly used programming language.

Given its versatility and a wide ecosystem of frameworks and libraries, the language offers sufficient resources for startups and small companies to build their product from scratch. A huge advantage of JavaScript is that it can be used for both the frontend and the backend, which could be beneficial for organizations that don't employ many programmers.

Language popularity by company size: 1-10 people



Language popularity by company size: 11-50 people



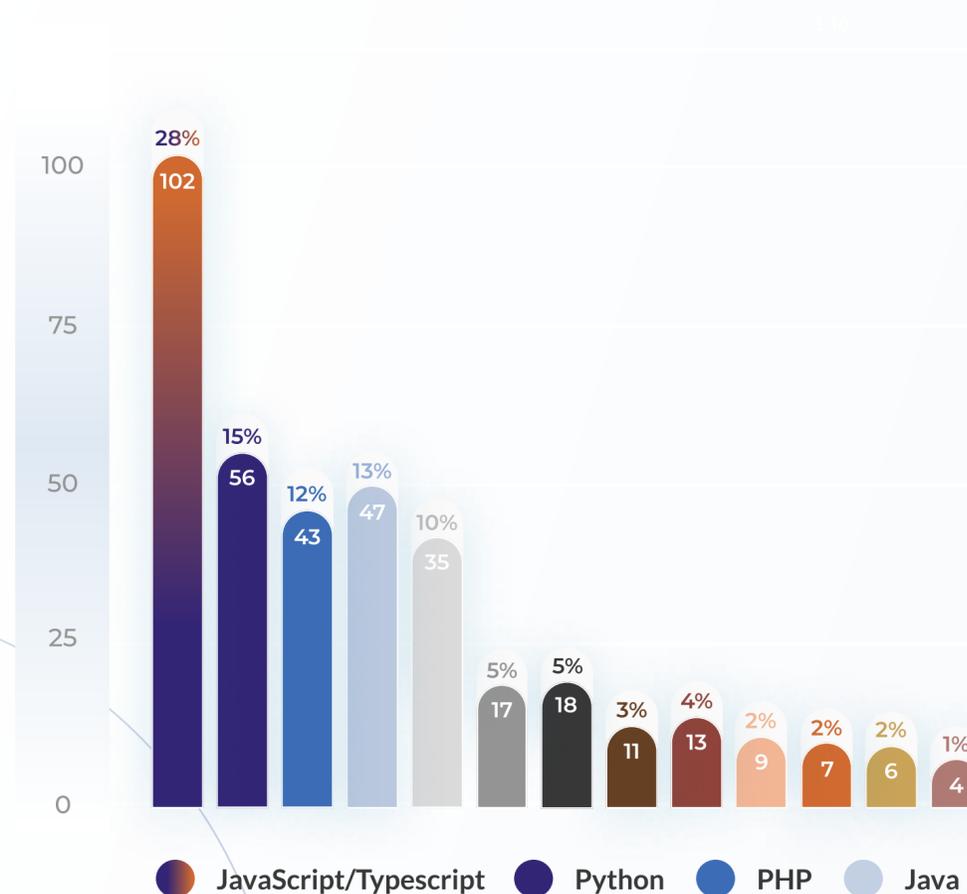
Programming languages chosen by their strengths: JavaScript and Python appeal to SMEs, large companies favor Java and JavaScript

JavaScript continued to be the most commonly used programming language for organizations with 51-250 and 251-1000 employees.

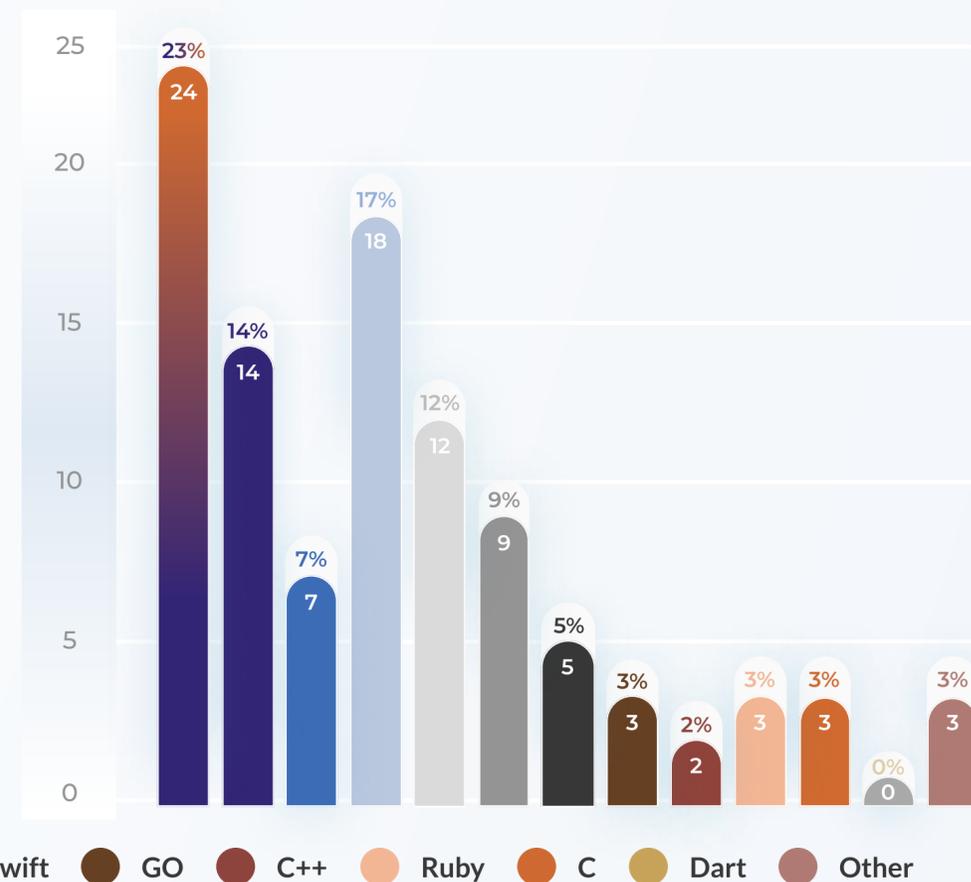
Python is consistently in second place for companies of up to 250 people. Small and medium-sized enterprises (SMEs) may be looking to expand and choose Python due to its scalability. Python is also favored due to its versatility and the speed in which it allows prototypes to be created and products to be launched on the market. These benefits go some way to explaining Python's popularity.

The popularity of Java increases as the company size gets bigger. Java is the second-most popular language with organizations employing 251-1000 people.

Language popularity by company size: 51-250 people



Language popularity by company size: 250-1000 people



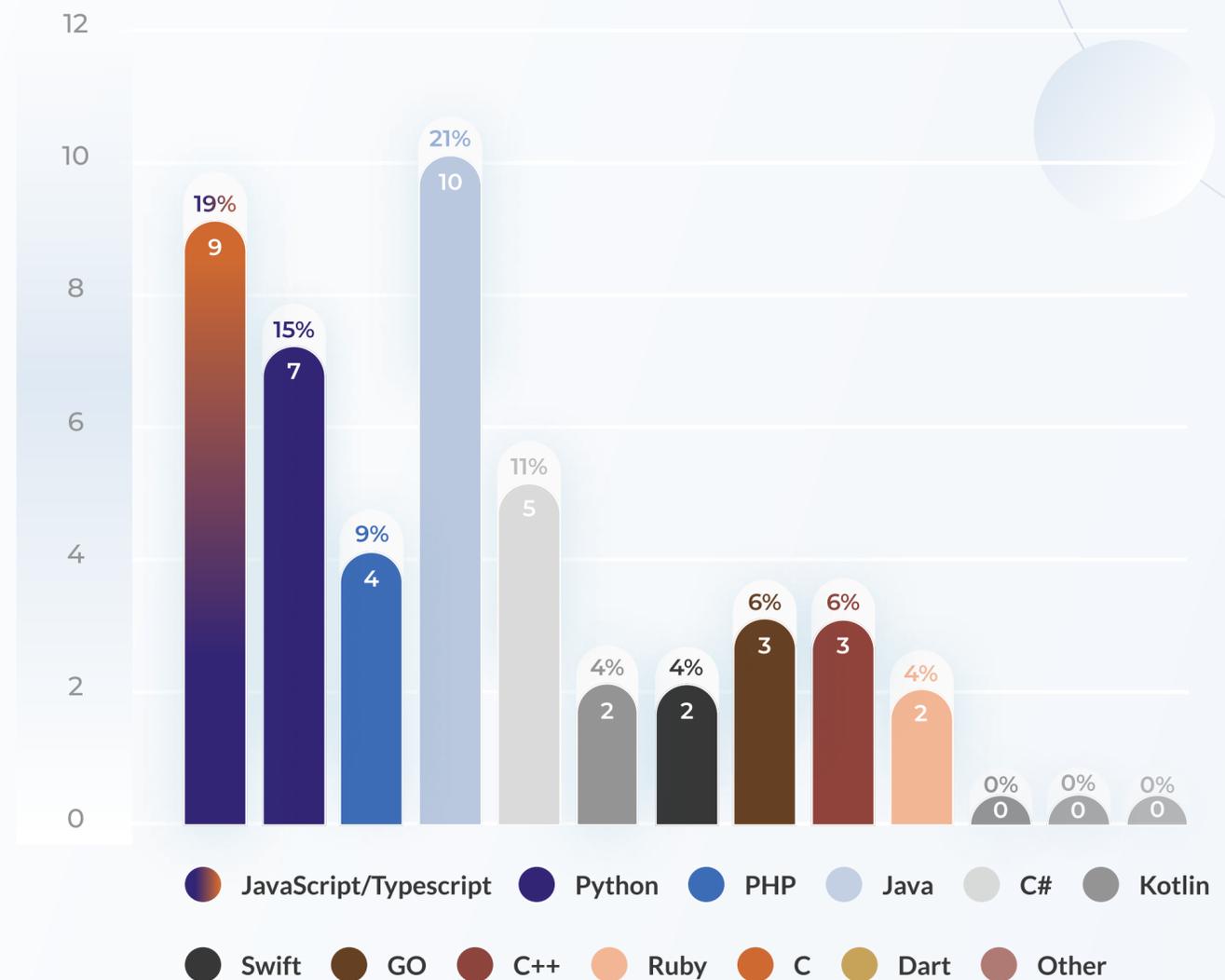
The bigger the organization, the more popular Java is—but JavaScript and Python are also commonly used by corporations

The largest companies in our survey are more likely to use Java. Only in organizations with over 1000 employees was Java rated as the most popular language.

Java has a reputation for being a **language of choice for big businesses**; Amazon, Google, Uber, Netflix, Slack, and Spotify, are all reported to include Java in their tech stack.

Aside from Java in #1, the rest of the top 3 is unsurprising: JavaScript and Python are a common element in the tech stack of organizations of all sizes, including the largest ones.

Language popularity by company size: over 1000 people



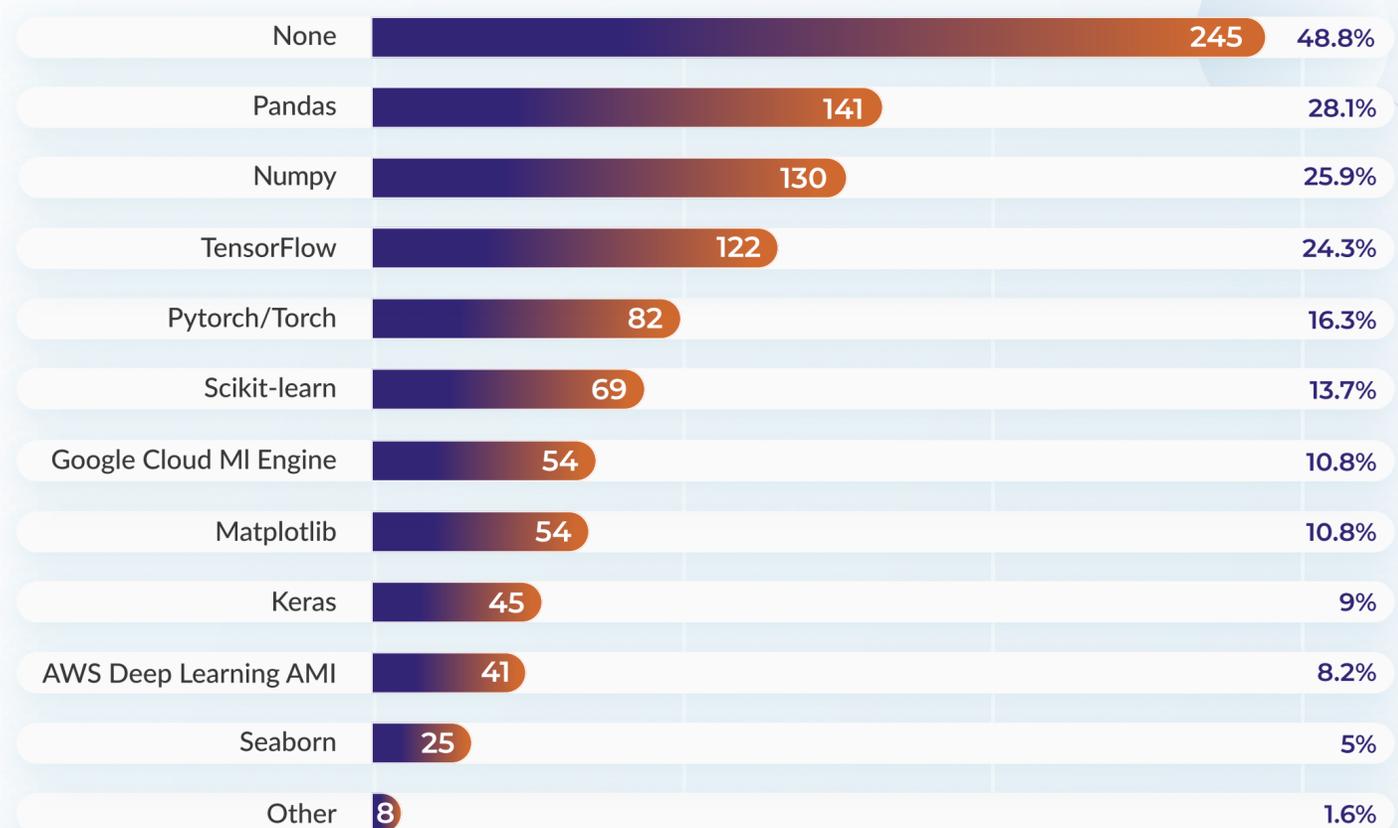
Data science: Python is still the most important language in this field—but almost half of our CTOs are not leveraging the full potential of data science

The top three data science frameworks remain the same as last year's survey: NumPy, TensorFlow, and Pandas.

The fact that these frameworks are the three most commonly used shows the strength Python has when it comes to data science. NumPy and Pandas are Python libraries. TensorFlow, although able to be used with other languages, is used most frequently in conjunction with Python.

Due to the known benefits of data science, it's surprising that almost half of all respondents' teams did not utilize data science using a framework. If your team is part of the 51% that does use a framework, you are at a clear advantage.

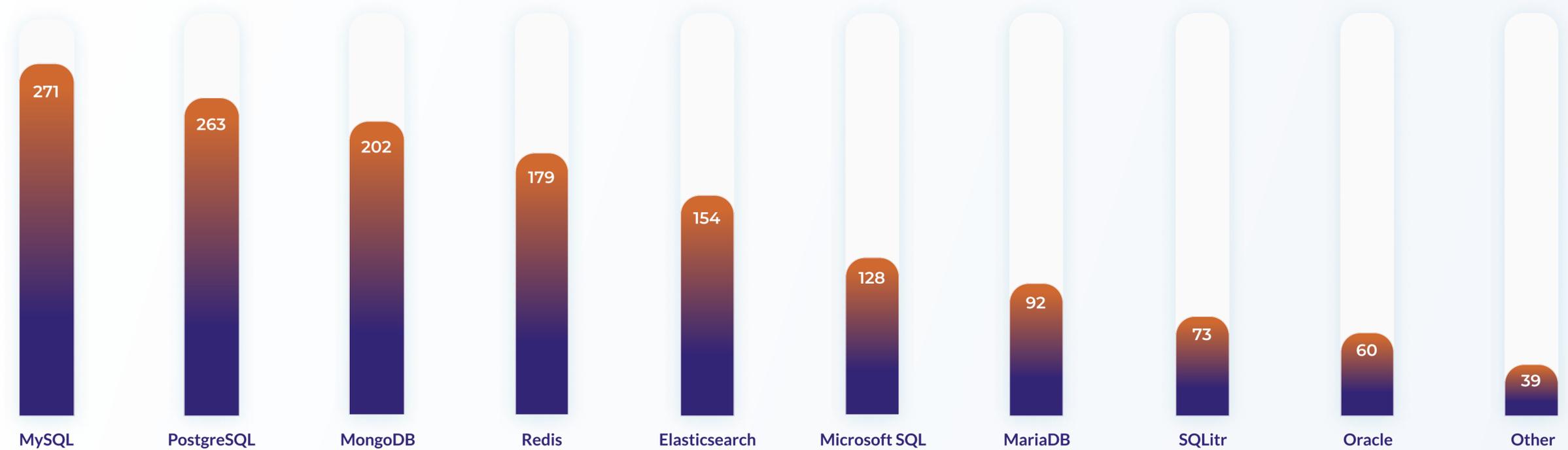
What data science frameworks do your teams use?



MySQL, PostgreSQL, and MongoDB are the most commonly used databases

It's common for our respondents' teams to use multiple databases, the most popular being MySQL, PostgreSQL, MongoDB, and Redis. There was very little difference between the top two databases; 53% of our CTOs' teams used MySQL against 52% for PostgreSQL. These databases have found popularity through their reliability, security, scalability, and the benefits of being open source.

What databases do your team use?



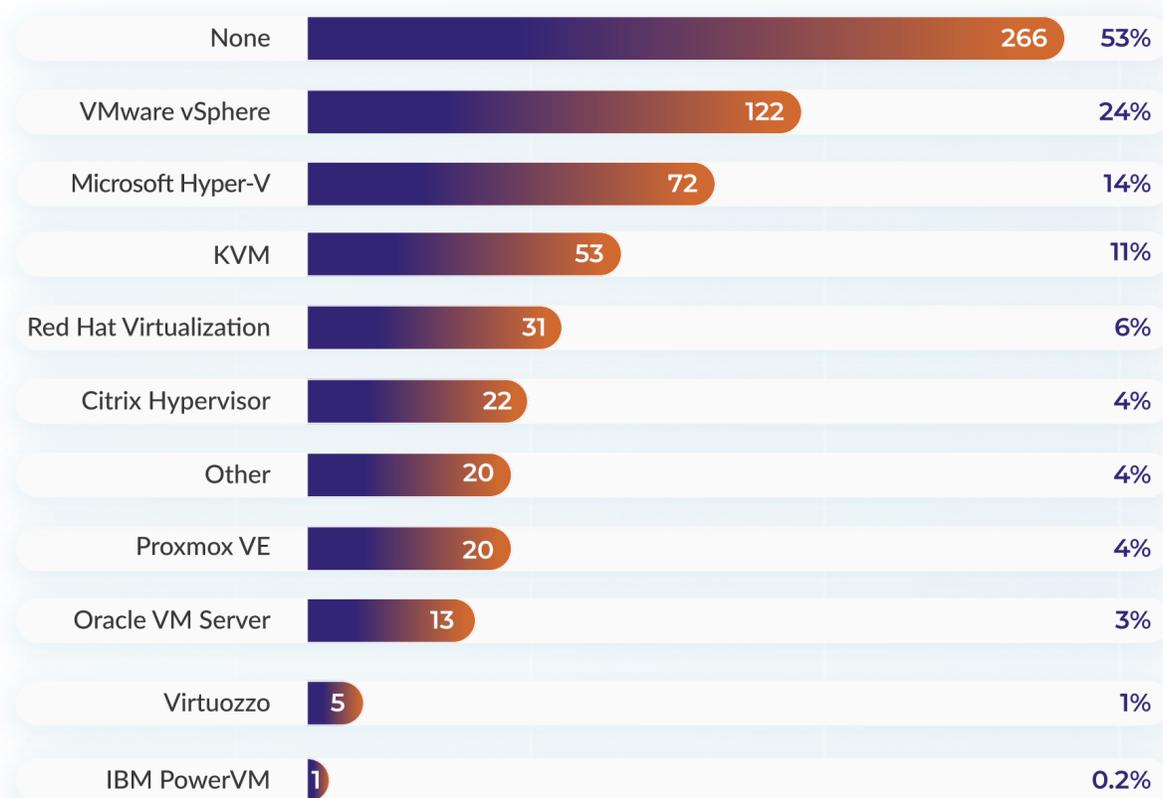
Over half of CTOs don't use server virtualization software

As many as 53% of our respondents do not use any server virtualization software.

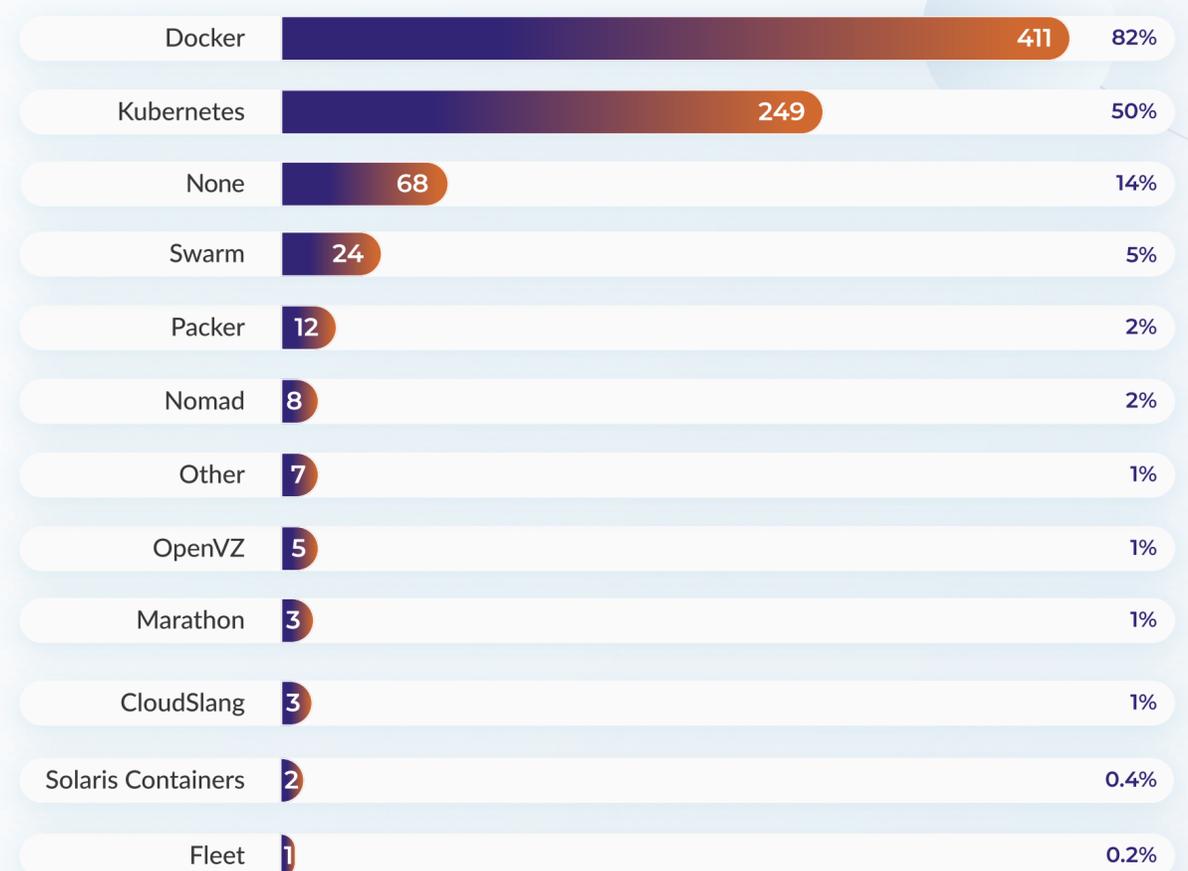
Among those who do use it, VMware vSphere and Microsoft Hyper-V are the most popular choices.

Docker, just like last year, is leading the category of containerization tools used by CTOs' teams, followed by Kubernetes.

What server virtualization software do your teams use?



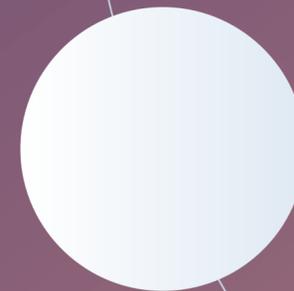
What containerization tools do your teams use?



03

Trends & technologies

The direction that tech
is heading for CTOs

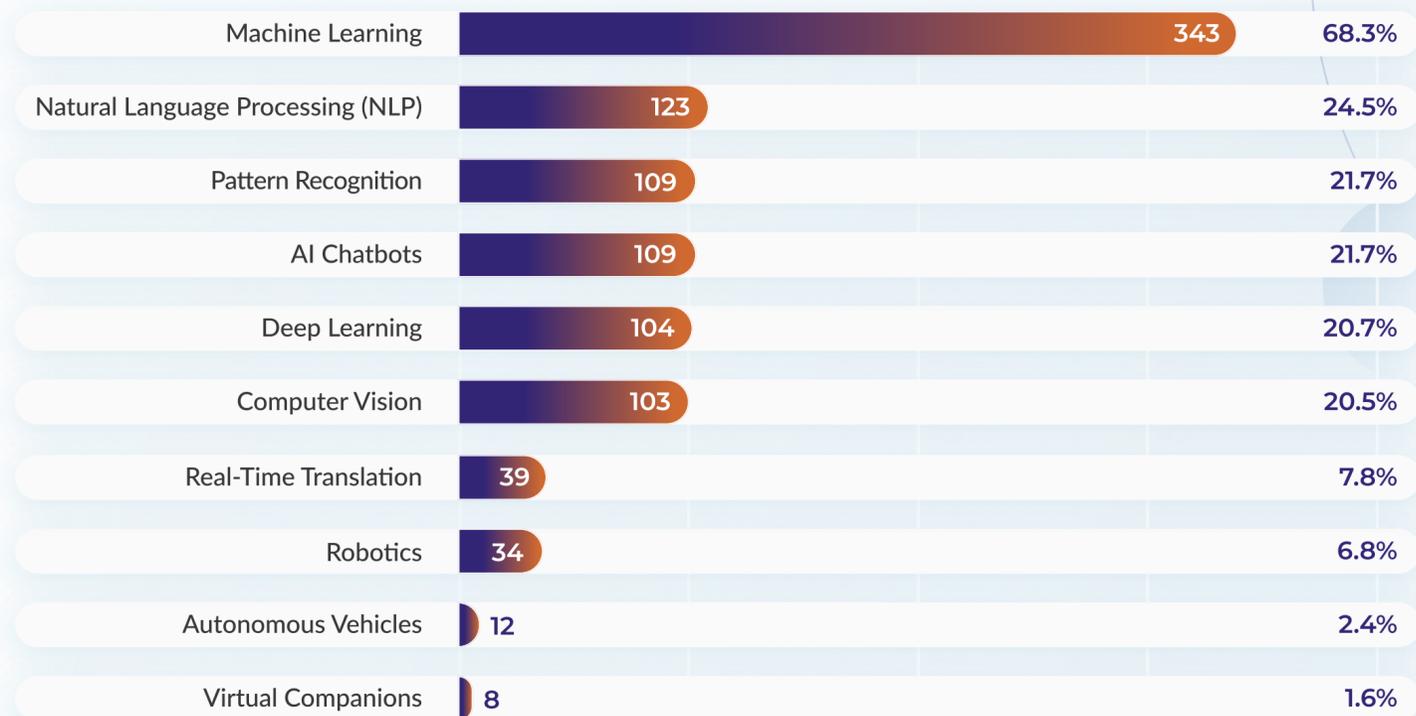


2 out of 3 CTOs have already implemented machine learning in 2021

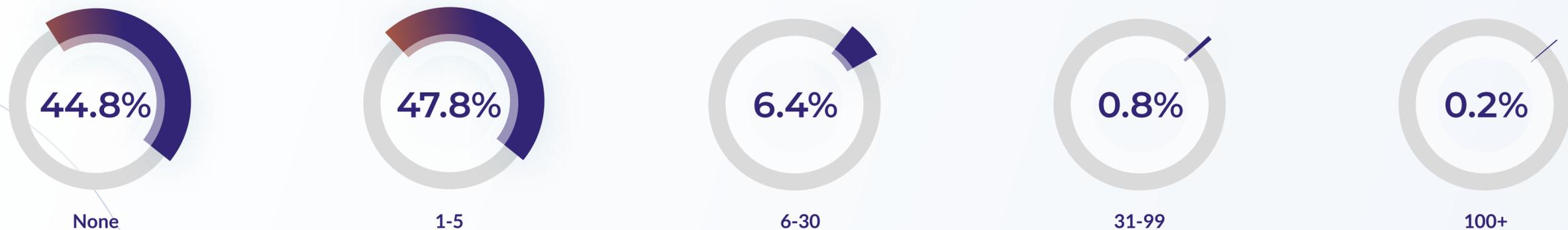
Machine learning is, by far, the most popular AI subset to be implemented; 68.3% of all CTOs who participated in the survey told us that machine learning has been applied in their company or organization. There is a significant jump to the second-most-common AI area: Natural Language Processing which has been implemented by 24.5%.

Over half (55.3%) of the respondents said their company employs at least one person to work in a dedicated AI/ML/Data Science capacity. Of the companies who have designated AI/ML/Data Science roles, 86.6% have up to 5 people working in these positions.

Which AI technologies have you implemented?



How many team members do you have in dedicated AI / ML / Data Science role?



Expert commentary

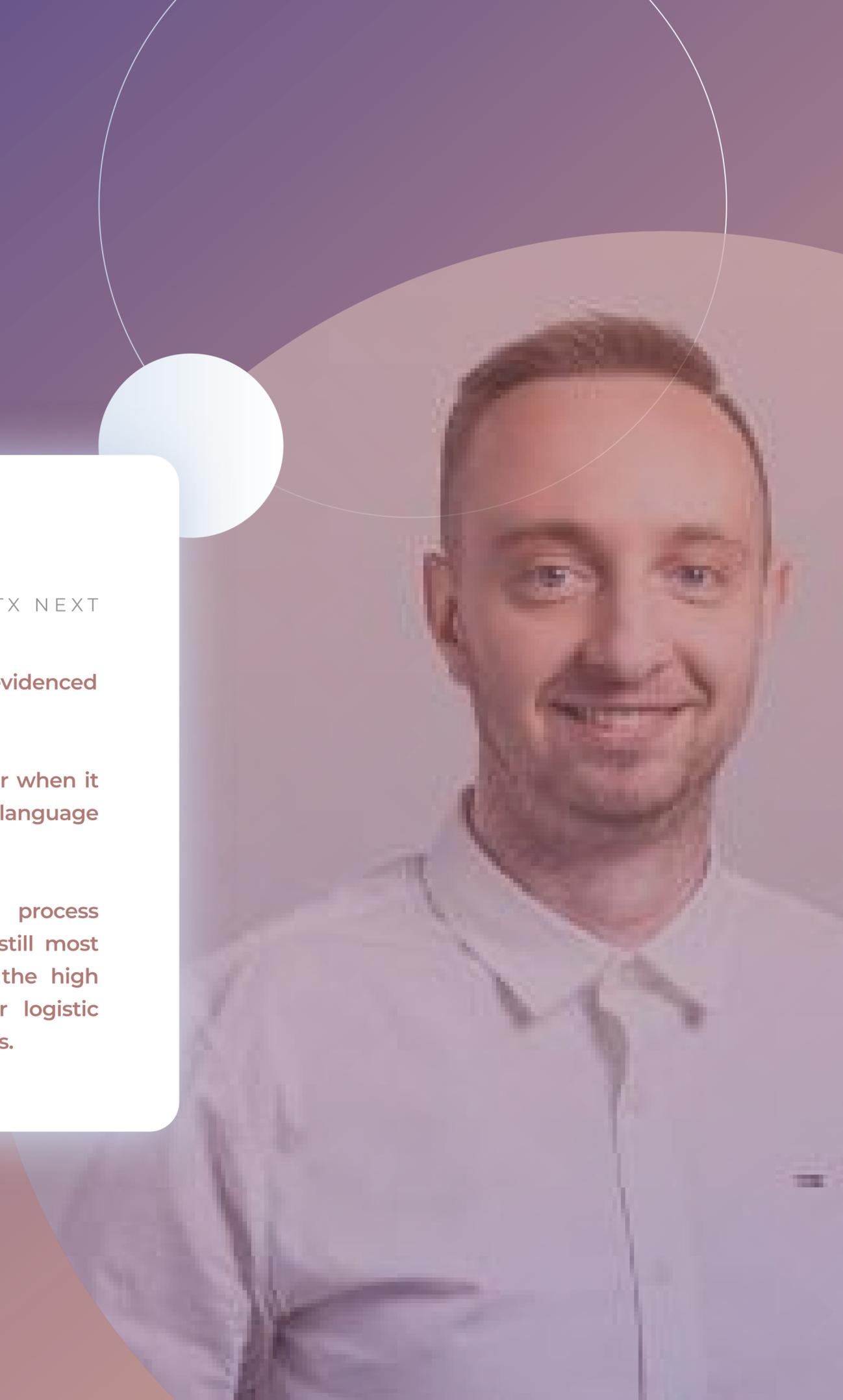
Łukasz Grzybowski

HEAD OF MACHINE LEARNING & DATA ENGINEERING @ STX NEXT

The implementation of AI in many companies is still in its early stages, as evidenced by the prevalence of small AI teams (up to 5 people).

Deep Learning is currently the fastest developing area of AI, in particular when it comes to its application in natural language processing, natural language understanding, chatbots, and computer vision.

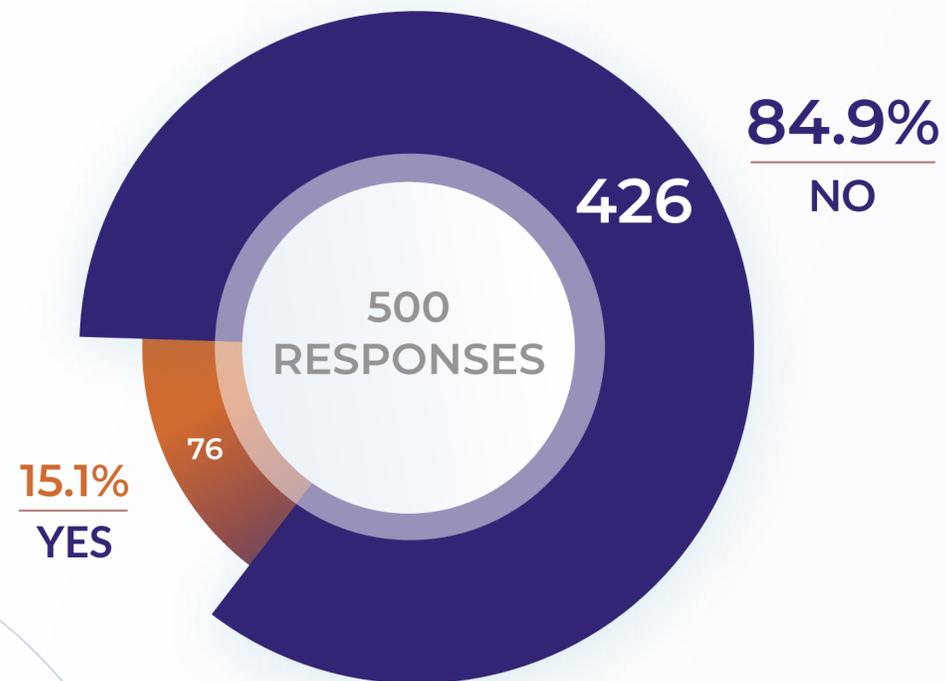
Many innovative companies are trying to use Deep Learning to process unstructured data such as images, sounds, and texts. However, AI is still most commonly used to process structured data, which is evidenced by the high popularity of classical machine learning methods such as linear or logistic regression, decision trees, random forests, and gradient boosting machines.



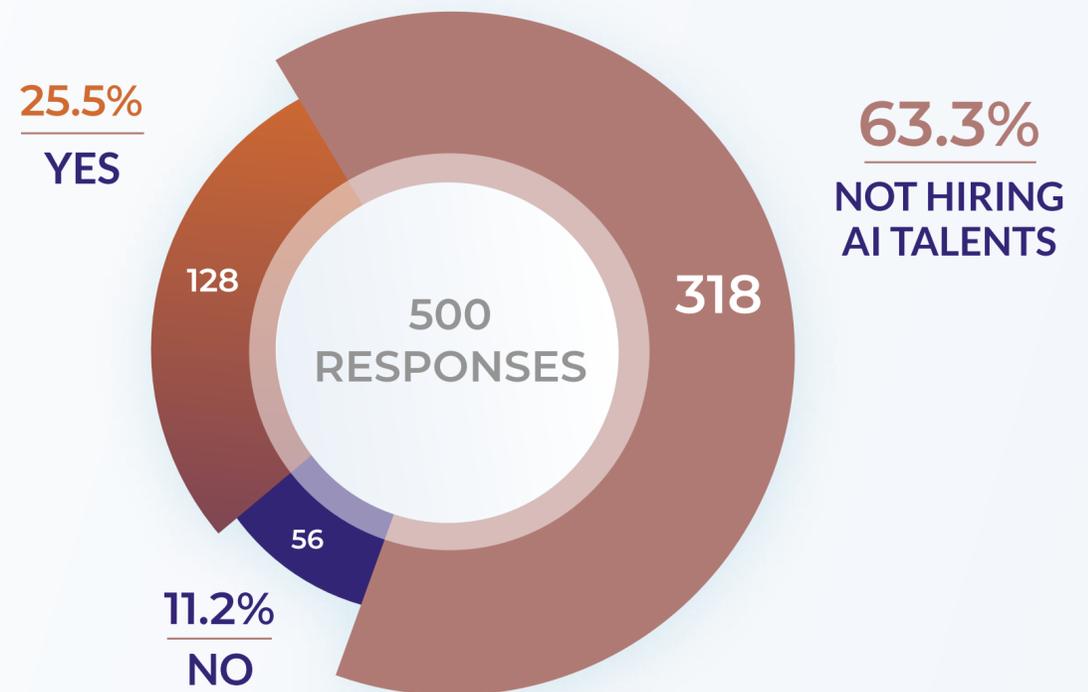
Artificial intelligence is growing—but most respondents' companies do not have separate AI teams

It is no secret that artificial intelligence is growing and the use of AI will only continue to increase—along with the worldwide market revenue for AI. In 2021, the global AI market has reached US\$327.5 billion. Yet, the majority of CTOs are working in companies without a team or department solely dedicated to AI. Just 15.1% said that their organization had a separate AI division. This is a trend that may not change in the immediate future either; most CTOs were not actively hiring for AI positions at the time of the survey.

Do you have a separate AI division?



Do you face difficulties when hiring AI talents for your organization?

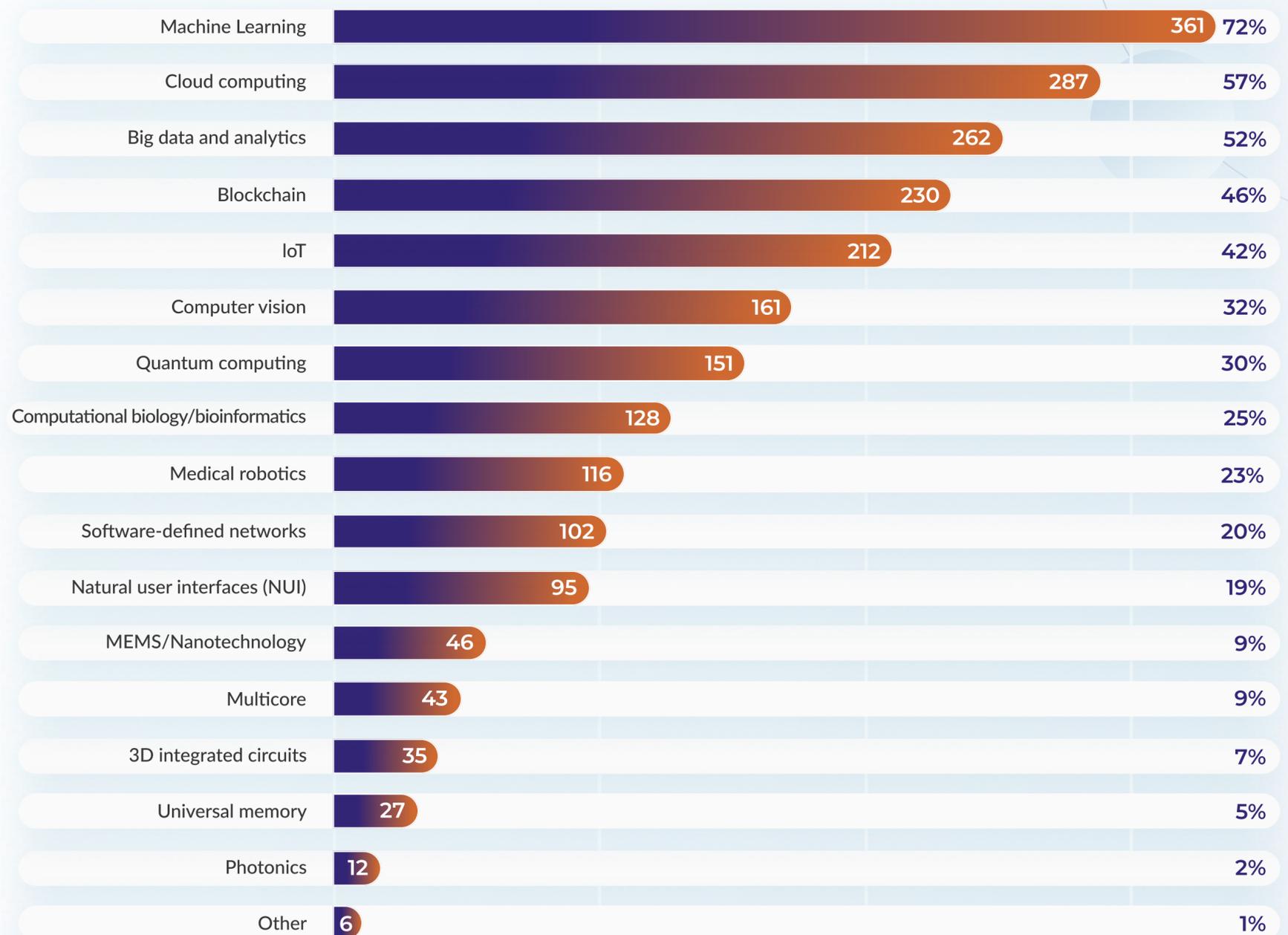


Machine learning, cloud computing, and big data are very popular—but CTOs predict they will become even more prominent

Last year's survey found that machine learning and artificial intelligence were predicted to be the two biggest technology challenges that companies will need to overcome in the upcoming years. Our data this year shows that three-quarters of CTOs have already implemented Machine Learning—and ML is only predicted to grow. Closing out the top three are cloud computing and big data: both quite prominent already and yet CTOs see them becoming even more widespread.

As cryptoassets become more commonplace, CTOs are also predicting a rise in prominence for blockchain over the next few years. Although widely associated with the exchange of cryptocurrencies, blockchain could be applied to a plethora of uses from securing digital medical records, combating election fraud, and tracking musical royalties.

Which technologies and trends do you think will become much more prominent in the next 2-4 years?



Expert commentary

Marcin Zabawa

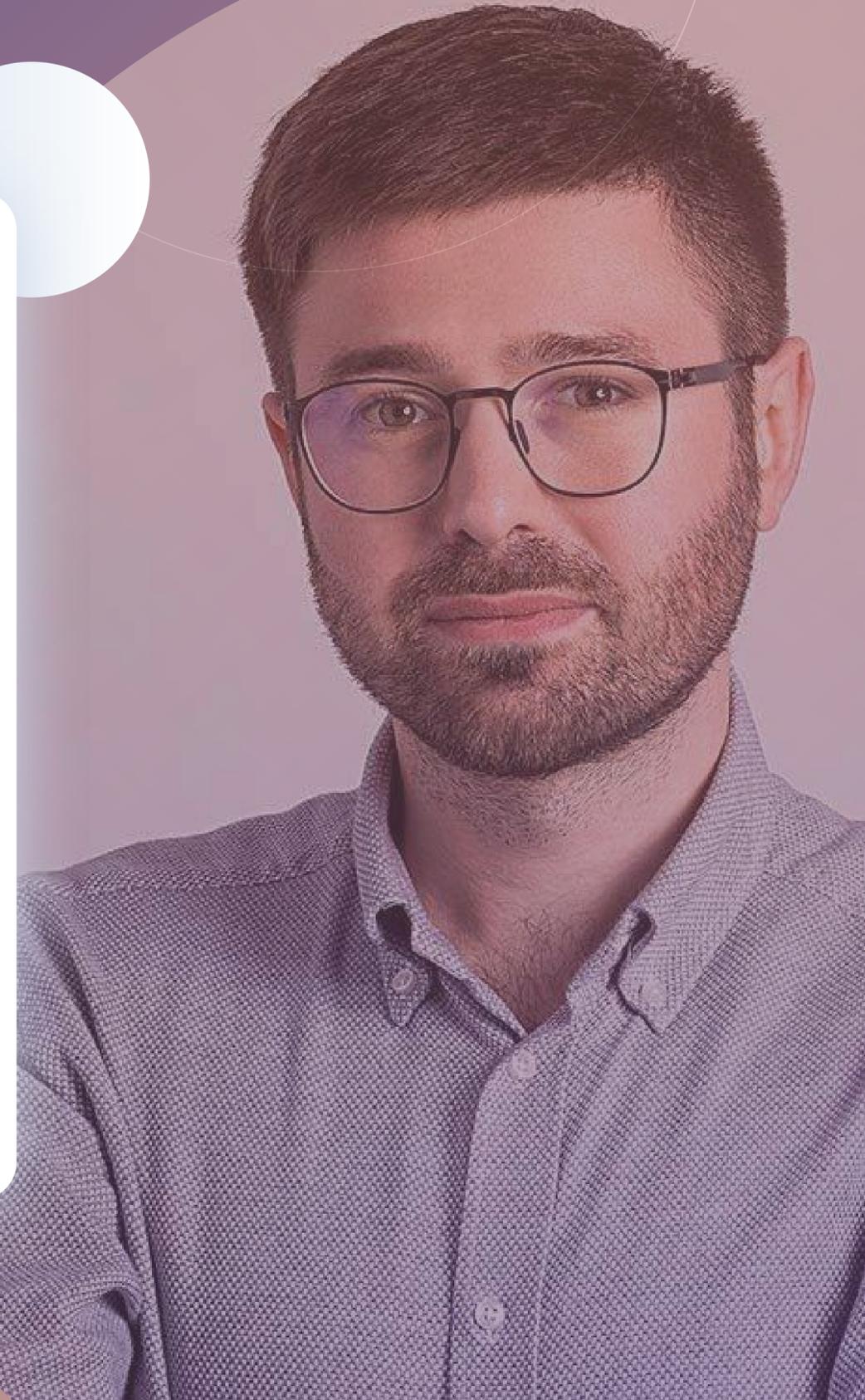
DIRECTOR OF CORE SERVICES @ STX NEXT

It's unsurprising to see machine learning as a definite leader when it comes to future technologies. What's less obvious is the skills that people will need to take full advantage of its growth and face the challenges that will arise alongside it. As a result, MLOps is an area that we're working to develop further at STX Next.

Even though blockchain was said to be a fad, it's still hugely popular. Perhaps one of the reasons it's ranked so highly is that it's constantly on the media. You might recall the NFT story that made the headlines this year.

You could say that the technology has matured. There are more and more stories about blockchain's negative impact on the environment, for instance its carbon footprint.

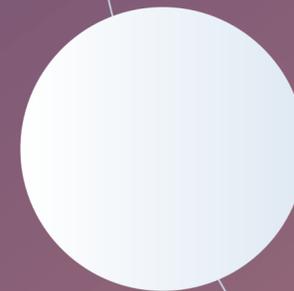
The same applies to machine learning. After the initial boom, concerns appeared about the ethics of some of its algorithms.



04

Security

How CTOs are managing
risk and protecting data
and IP



42% of CTOs say their companies have no cybersecurity at all

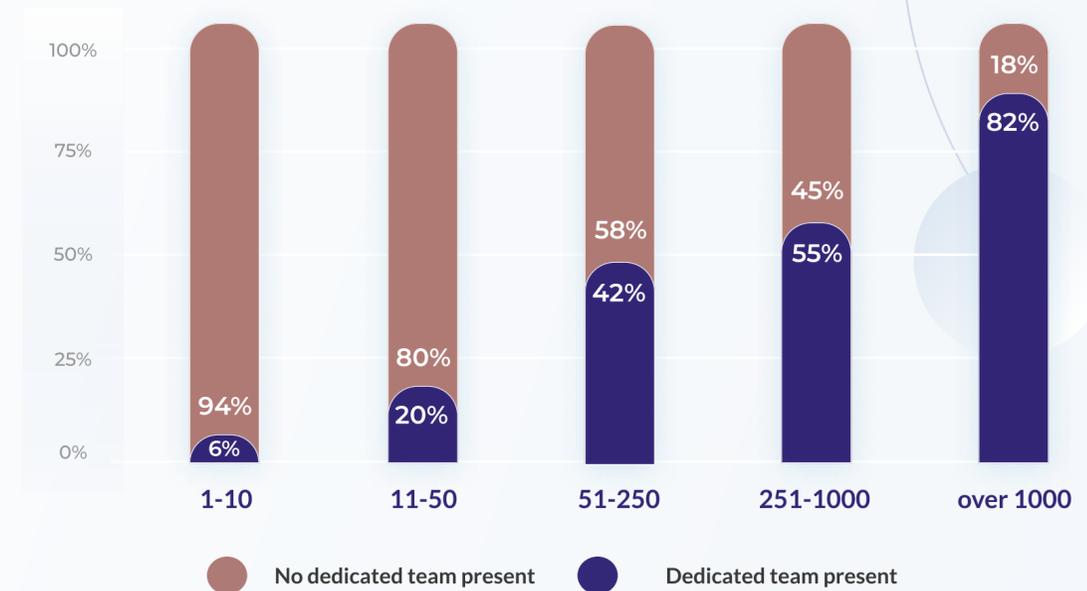
One of the key ways organizations can effectively protect themselves against the expanding number of cybersecurity threats is by having a dedicated in-house security team or outsourcing the services to an external agency.

However, we found out that as many as 42% of our respondents (211) have neither in-house nor outsourced cybersecurity. The vast majority of them are small companies that employ up to 50 people: the smaller the company, the less likely it is to have any cybersecurity.

In total, only 25% of CTOs said that their organization has an internal dedicated security team. The number of companies that outsource is roughly divided in half.

Organizations with a headcount of at least 1000 are more likely to have an in-house team than to entrust their cybersecurity to an external company.

Implementation of dedicated security teams by company size



Do you have a dedicated team or department providing security services in your organization?



Are you using the services of external specialized companies for security and cybersecurity?



Not all European companies enforce GDPR

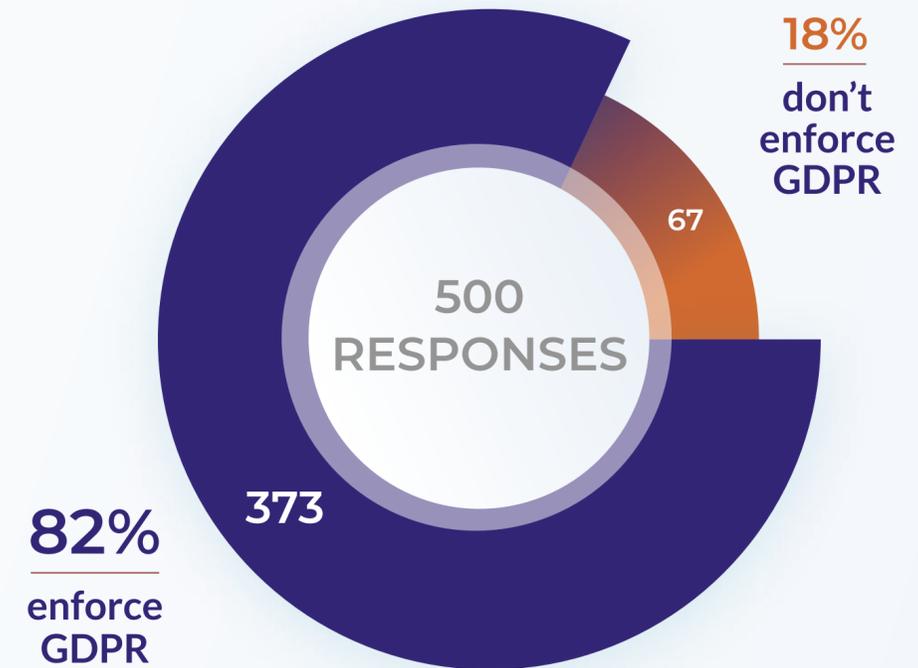
Even though GDPR is the most commonly enforced regulation based on the total number of answers we received, it's important to note that the EU policy is not applied by all European companies we spoke to.

Among organizations from Europe who took part in the survey, 67 out of 373 said they do not enforce the regulation.

Which of the following standards and regulations do you enforce for the systems in your organization?



Among the European companies responding to the survey...



Expert commentary



Aleksander Czarnowski

CEO @ AVET INS AND CO-FOUNDER OF DEFENSELAYERS

Focusing mainly on GDPR compliance can be a trap in the long term. First of all, there is a whole new set of compliance regulations including privacy protection around the corner.

Secondly, many organizations still fail to implement GDPR's most basic requirements correctly. Article 25 is a perfect example: proper hardening, especially in the area of microservices, is non-existent in many cases.

Furthermore, organizations tend to use containers to deploy monolithic applications while still not meeting the "security by default, security by design" stance.



Bring-your-own-device policies don't have to mean less security

Even though bring-your-own-device (BYOD) policies might not be new, they have a renewed significance now that many employees are working from home. However, not all companies seem to like the idea of allowing their staff to use personal devices for work. Roughly half of our respondents said their organization does not have a BYOD policy, mirroring last year's results.

Interestingly, our data suggests having a BYOD policy doesn't necessarily make a company more vulnerable to attacks. Of the 38 companies that fell victim to a cyberattack in the past 12 months, 22 do not allow their employees to use their own devices for work.

Does your organization have a bring-your-own-device policy in place?



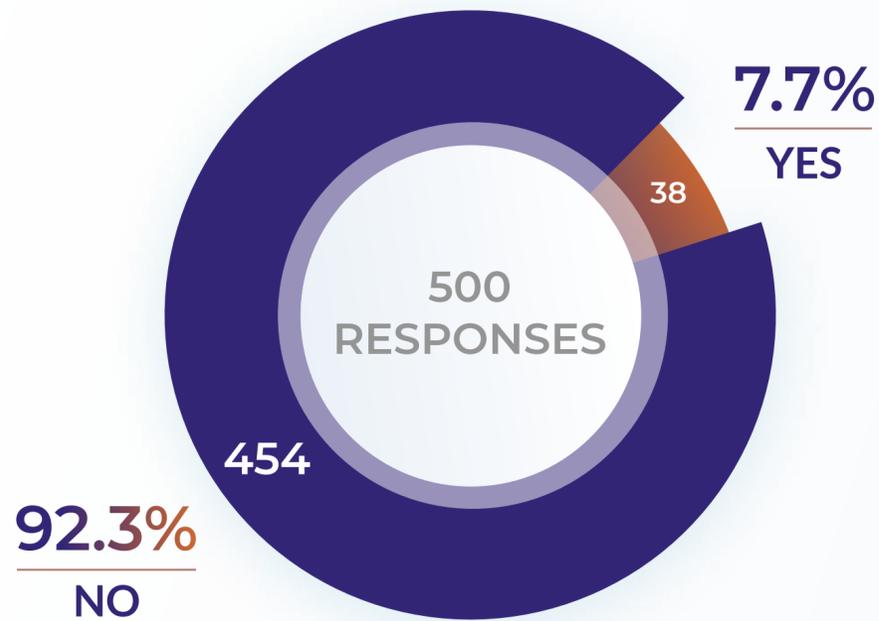
Of the CTOs who admitted that their companies fell victim to a cyberattack within the previous 12 months...



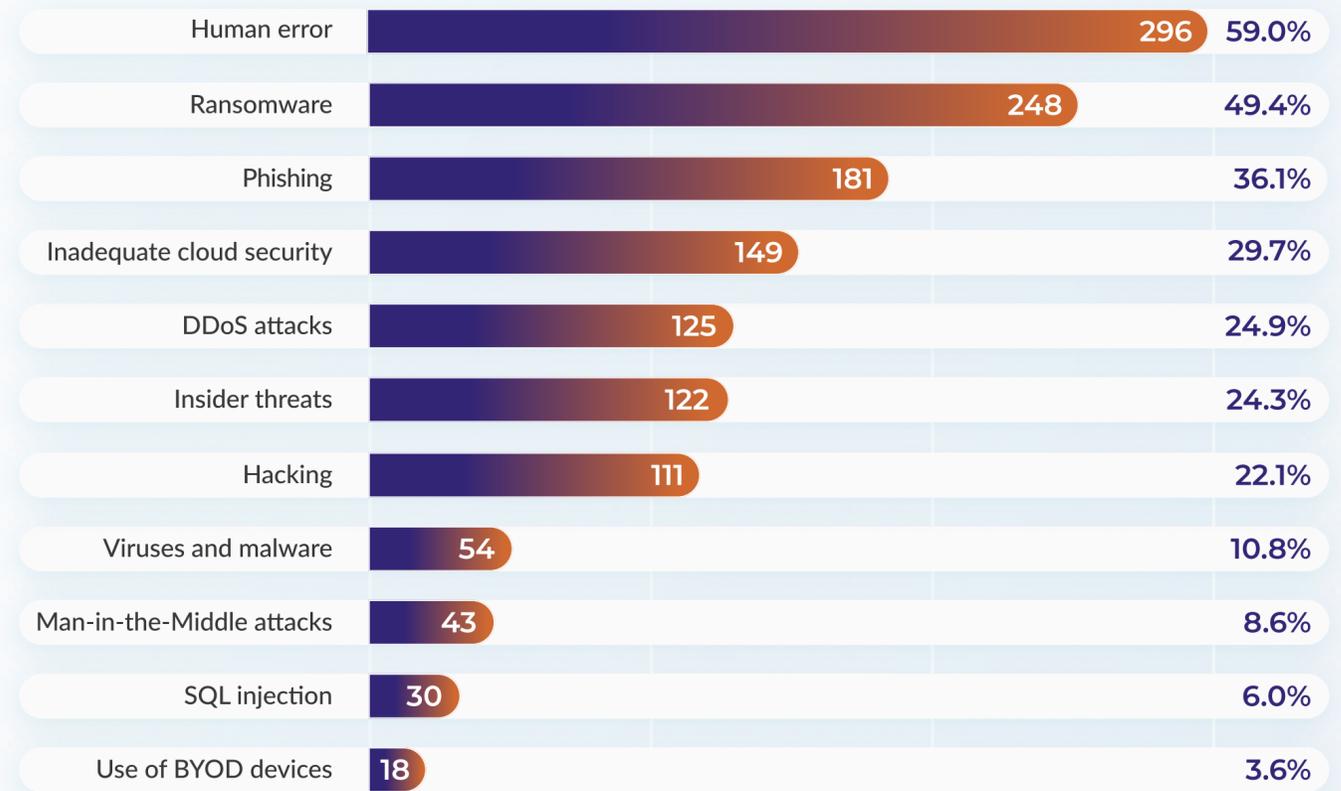
The biggest cybersecurity risk? Human error

Cyberattacks have taken on pandemic proportions in the COVID-19 era, according to media reports. Our figures show that roughly 1 out of 13 companies that responded to our survey fell victim to a cyberattack within the last 12 months—and that’s only the respondents that were both aware of the attack and willing to admit that it happened. Interestingly, 59% said that they consider **human error** the biggest security threat, above **ransomware** (49%), and **phishing** (36%).

Did your organization fall victim to a cyberattack within the last 12 months?



Which of the following do you consider the biggest cybersecurity threats?



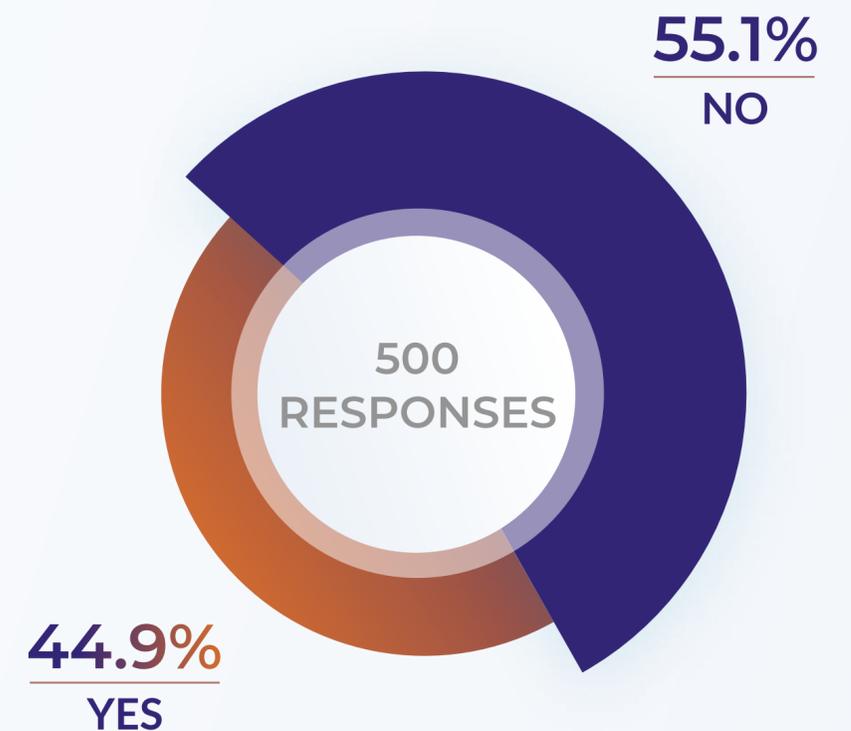
Most respondents don't have guidelines for container security

The vast majority of participants check the security of their organization's containers, either by themselves, by scanning them for vulnerabilities, or by relying on the help of their CI/CD vendor or cloud service provider. Yet, 55% do not have any specific company guidelines for container security.

How do you acquire container images?



Do you have any special security guidelines / best practices for container security deployed in your organization?



How do you check the security of your containers?



Nearly half of surveyed companies have no ransomware protection

As cybersecurity continues to be a serious concern for companies worldwide, the COVID-19 pandemic created even more urgency to tackle the threats.

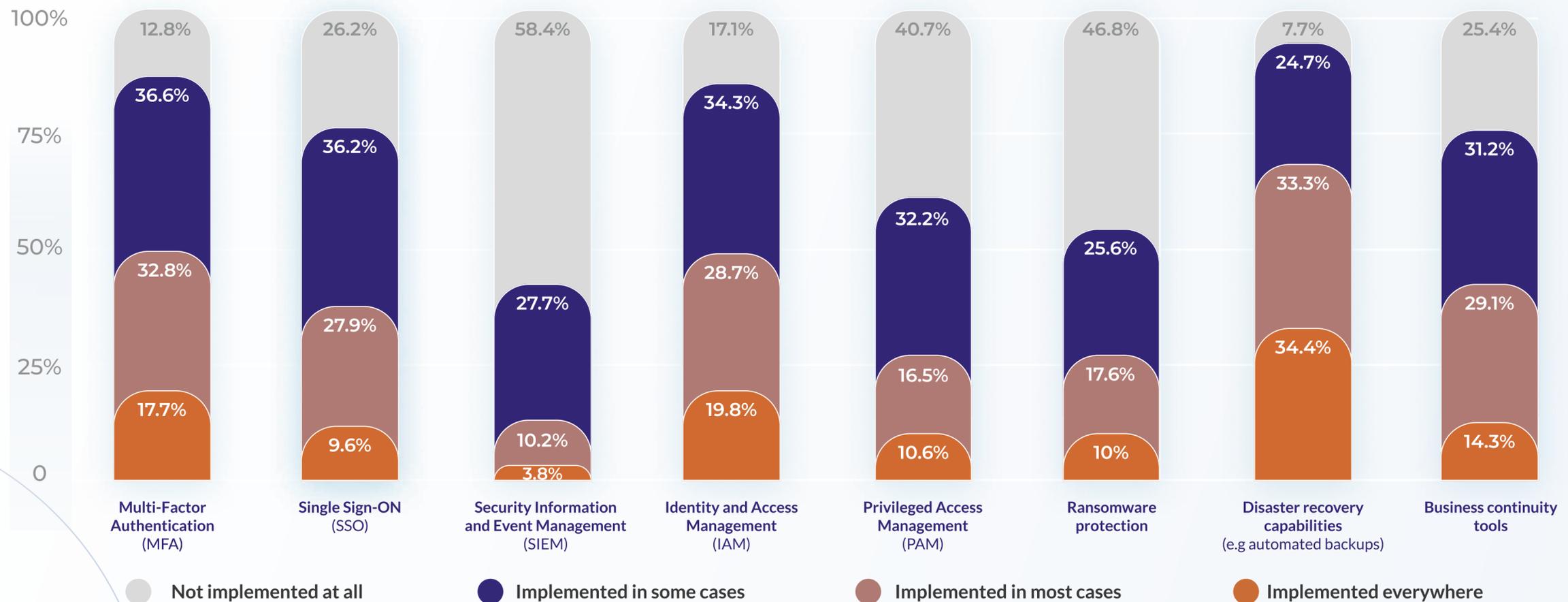
However, our survey shows that nearly half of the CTOs we spoke to say their companies have no ransomware protection. Only 10% implement it everywhere, and the rest do so either in some or most cases.

On a more positive note, Multi-Factor Authentication is implemented by 87% of respondents either everywhere or at least in some cases.

Disaster recovery capabilities (such as automated backups) are the most commonly adopted measures, with only 7.7% of responders admitting they do not implement them at all.

On the other end of the spectrum is Security Information and Event Management, which is present in only 58.4% of companies.

What's your adoption rate for...



Expert commentary



Aleksander Czarnowski

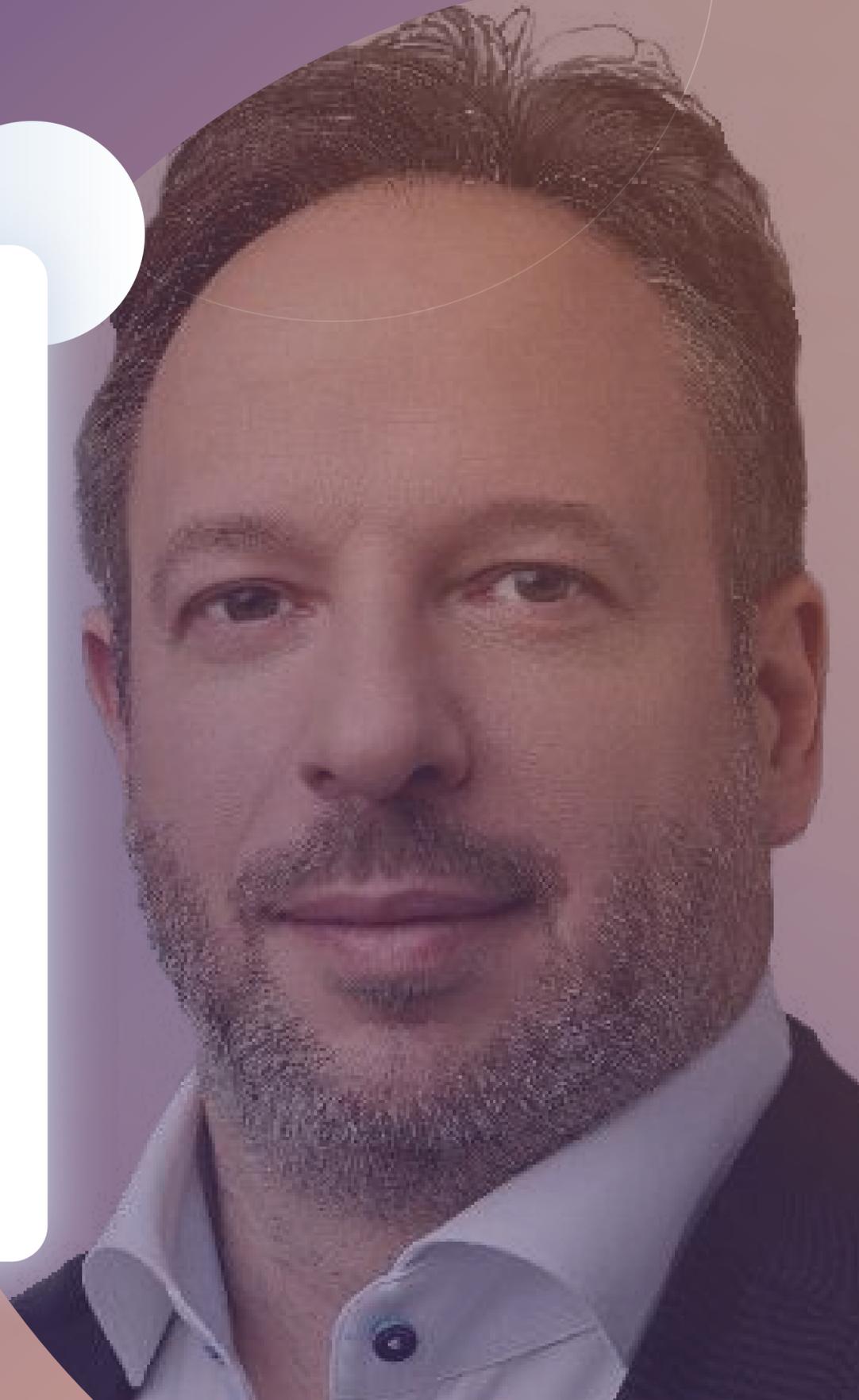
CEO @ AVET INS AND CO-FOUNDER OF DEFENSELAYERS

Humans are always the weakest link in any security model, and the fact that human error was ranked the biggest security threat seems a correct and unsurprising judgement.

It's very interesting to see ransomware occupying the second position on the list, especially when organizations still allow the deployment of untrusted container images, which often come with malware.

Container security is still not mature enough and we clearly see it not just from this report but also from our own research. However, this must change within the next two years due to the future cybersecurity and compliance challenges.

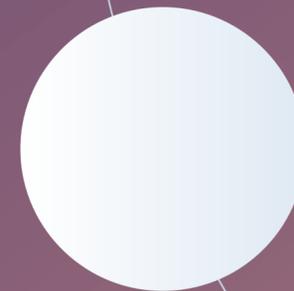
Finally, with regards to disaster recovery safeguards the challenge is not their deployment but constant testing in order to assure they are in line with real business needs and objectives. However this is a time- and resource-consuming process, so it is often simply skipped... until the first real incident.



05

Management & leadership

How CTOs are helping their
teams do their best work

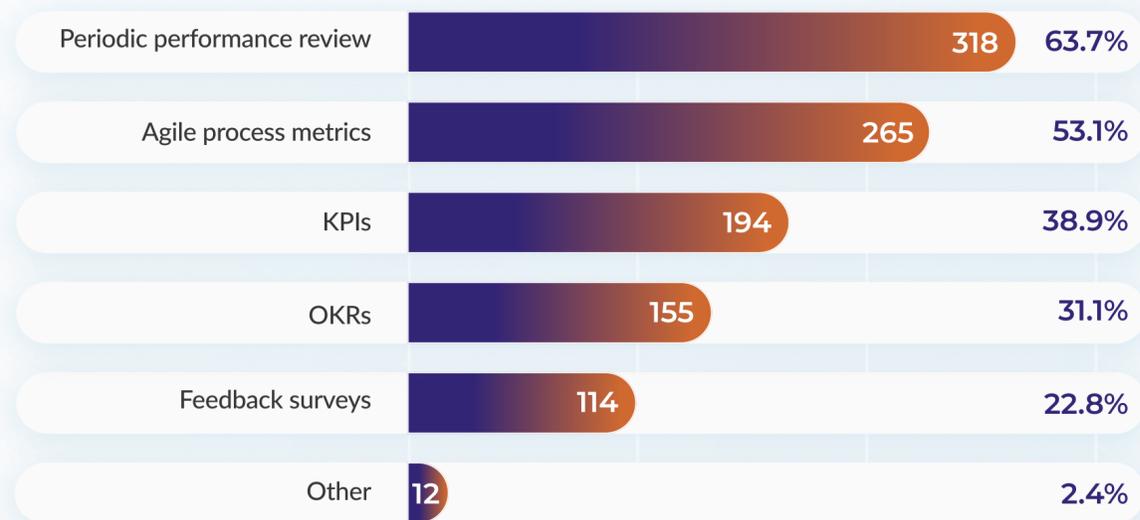


1 in 5 CTOs has more than 10 direct reports

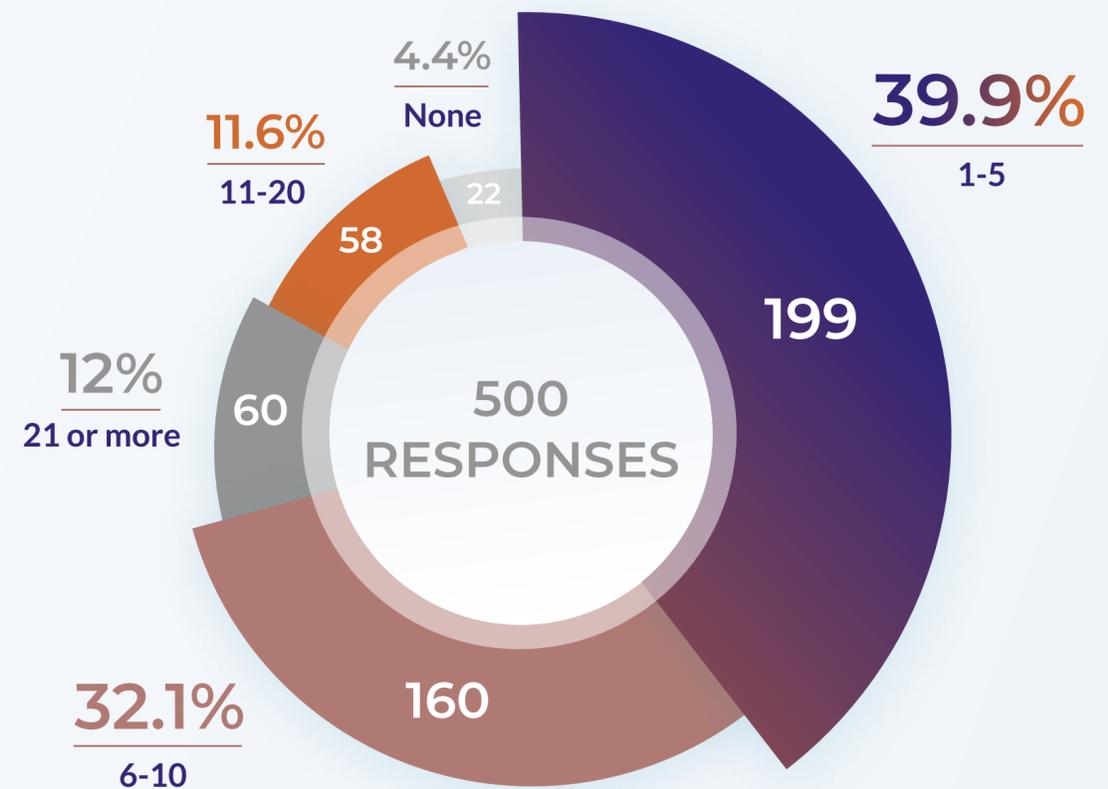
We know that CTOs pay very close attention to managing their teams well, so they try to keep their load of direct reports fairly balanced. Most typically, CTOs only have 1-5 direct reports. However, over 20% of the CTOs responding to our survey had much larger teams (10+ people) under their wing. Given that periodic performance reviews are still the most popular way of assessing teams' performance, it seems that 1 in 5 CTOs has quite a packed schedule when the time for performance reviews arrives.

As for other methods CTOs use to assess performance, it appears that OKRs are becoming more popular among CTOs; relative to last year's survey, they moved up by one position in the ranking, overtaking feedback surveys.

How do you measure your teams' performance?



How many people report directly to you?



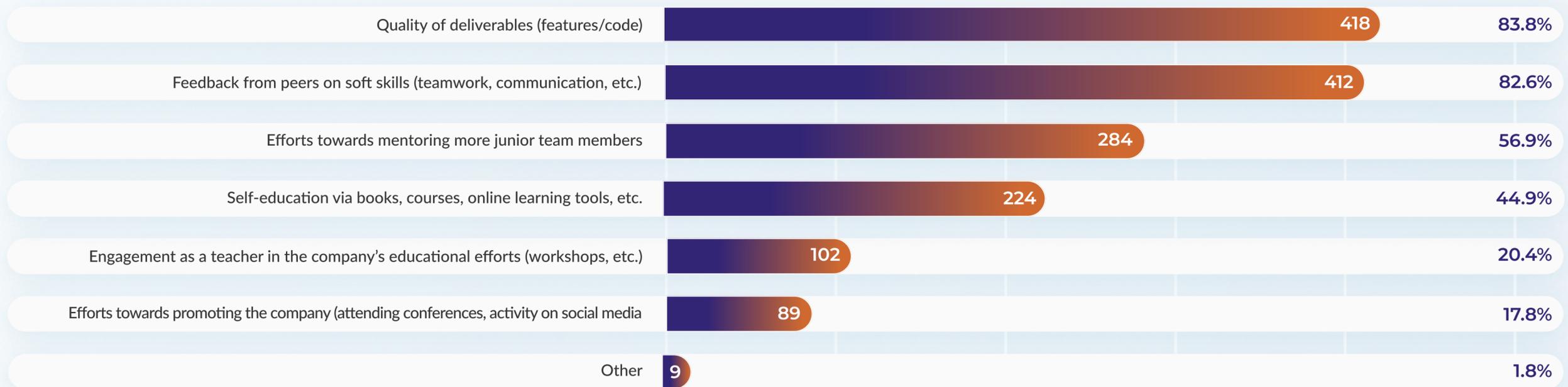
To impress your CTO, you need to code well and communicate well

If you want to be appreciated by your CTO, you best ship quality code. For the second year in a row, the quality of deliverables was deemed the most common influence when it comes to team members' assessments.

Coding isn't everything, however. Hot on its heels in our ranking of most important performance indicators is **feedback from peers on soft skills**. This shows that a strong mix of technical skills and communication skills is highly desired by CTOs.

Beyond that, developers looking to go the extra mile should look primarily at **mentoring junior team members** and **improving their own skills**—both were deemed twice as important as other activities like teaching at workshops and promoting the company during events and on social media.

Which of the following influence your assessment of team members' performance?



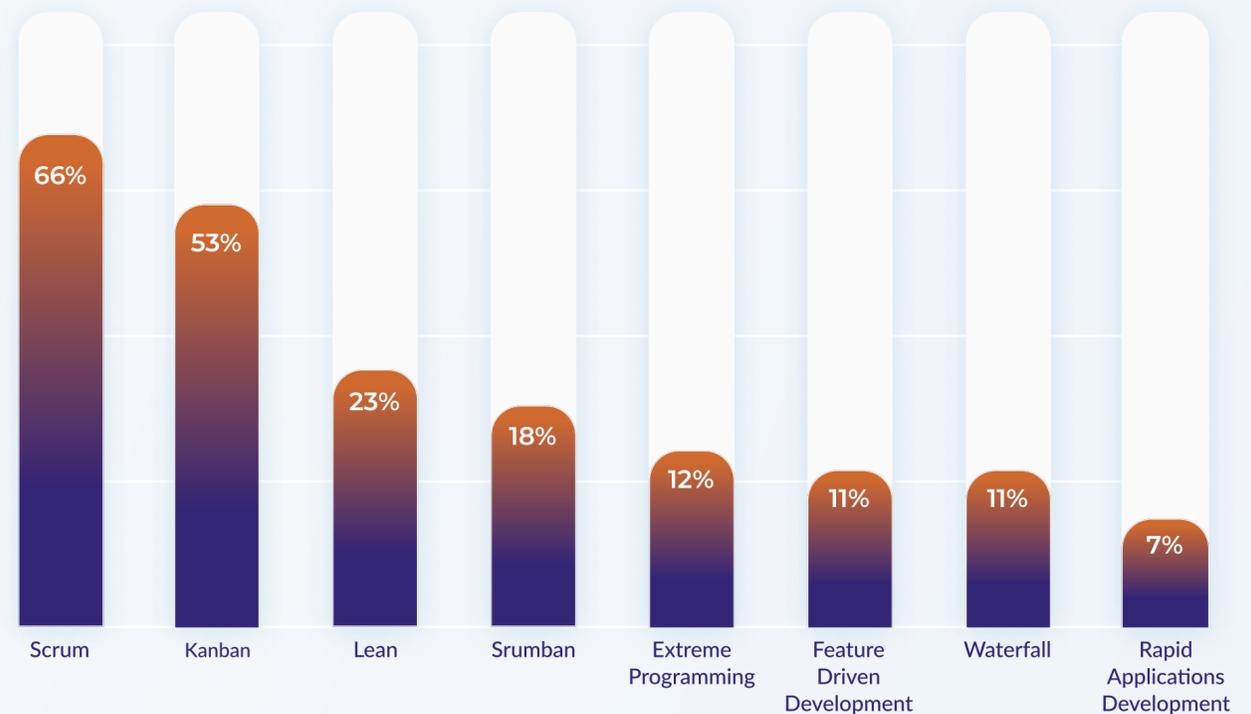
The popularity of Agile and Scrum are constant and undeniable

Analyzing the popularity of software development frameworks leaves us unsurprised relative to last year’s findings. The top 3 remains unchanged: **Scrum and Kanban are far ahead of the rest**, followed by Lean in third place (and Scrumban in fourth only serves to reinforce the popularity of the top two). This year, we also asked the respondents whether they participated in an Agile transformation. Surprisingly, a majority of our CTOs (62%) have participated in such a transformation, which goes to show that **the Agile mindset is well entrenched among most CTOs worldwide**.

Have you participated in an Agile transition /transformation?



What software development frameworks do your teams use?

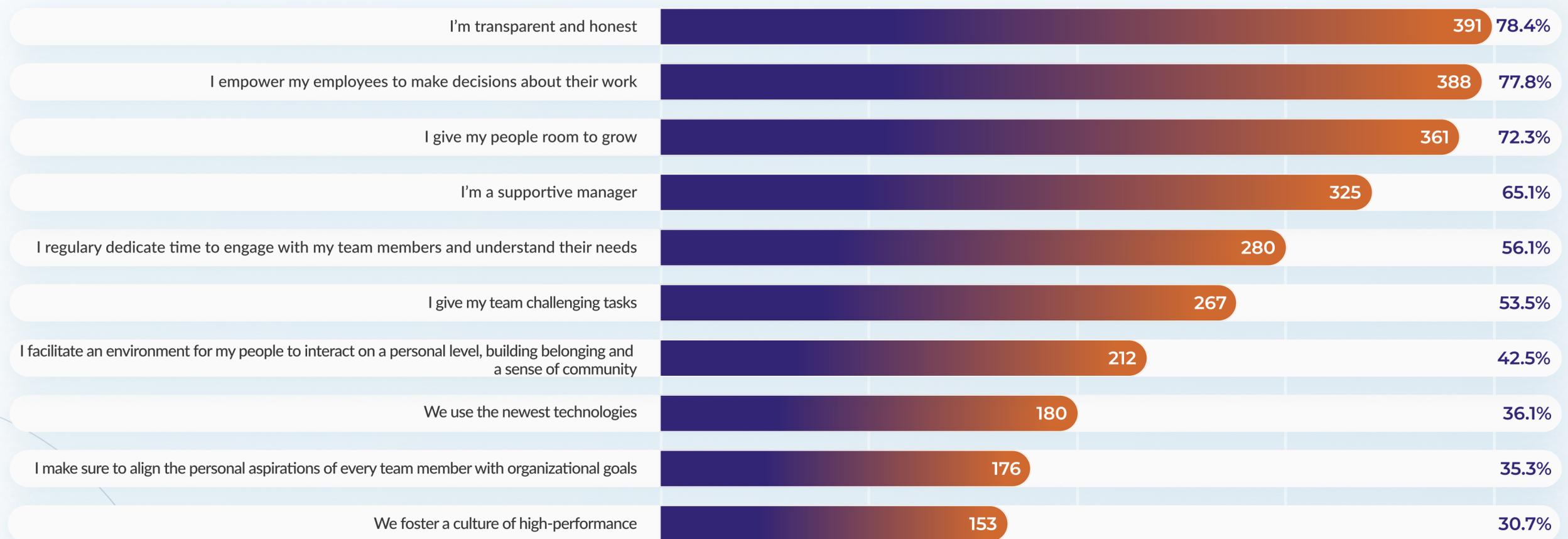


The CTO recipe for a motivated team: be honest with them, empower them to make decisions, and give them opportunities to grow

Facing high turnover rates and an extremely competitive job market for software developers, CTOs need to focus on keeping their teams motivated and happy more than ever before.

When asked about their winning strategies for keeping motivation high, our respondents typically said they focus on **honesty, trust, and growth** for team members. Those options won over some interesting alternatives: for example, **only 36% said they motivate their staff by using the newest technologies and only 54% said that they give their team challenging tasks to boost motivation.**

How do you keep your staff motivated?



Expert commentary

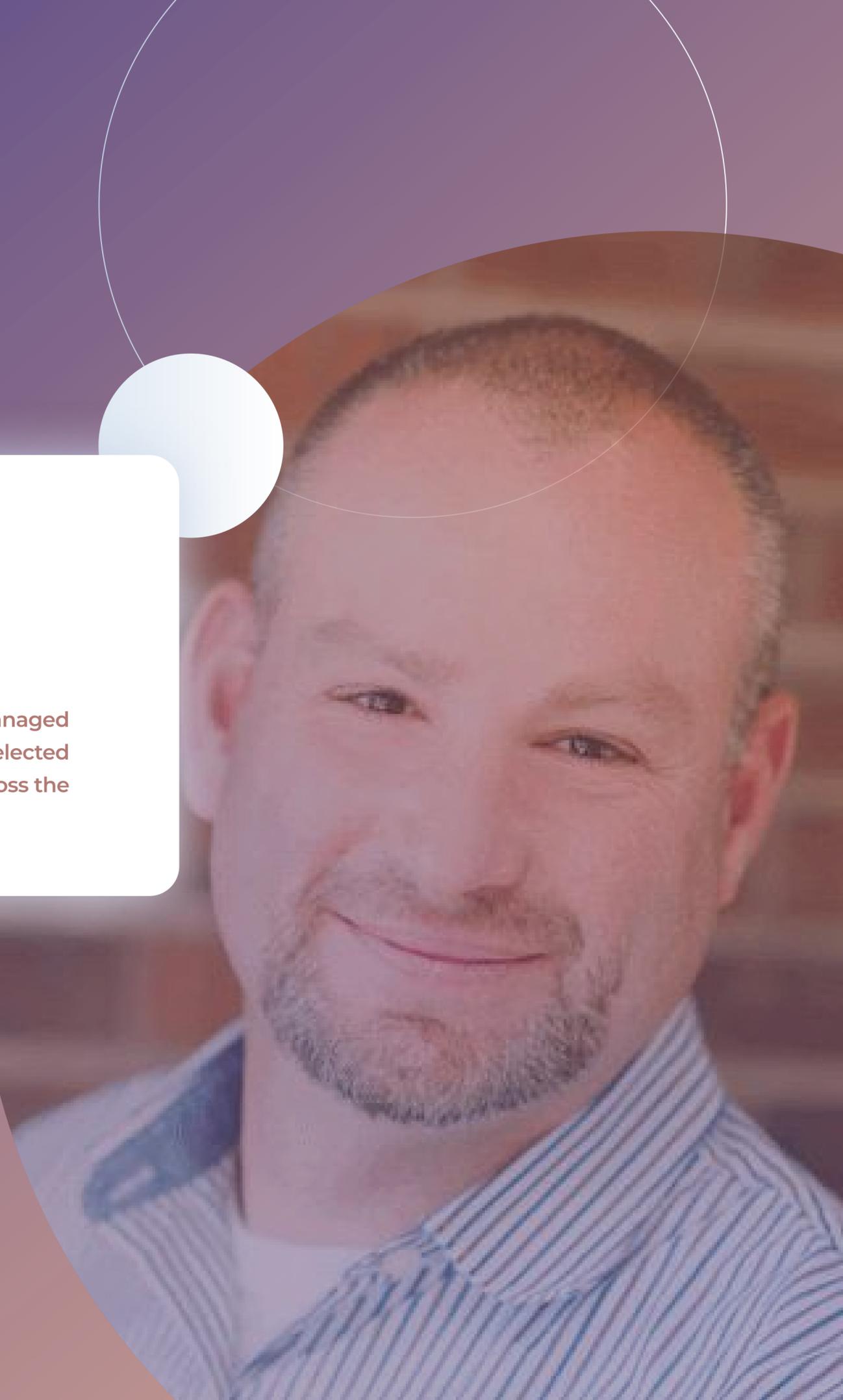


Scrum.org

Eric Naiburg

CHIEF OPERATING OFFICER @ SCRUM.ORG

It is great to see CTOs embrace the importance of empowering self-managed teams in their agile organizations. This combined with the other highly selected areas demonstrate the importance of trust and the need to build trust across the team and organization.



Increased remote work is not harmful for team relationships

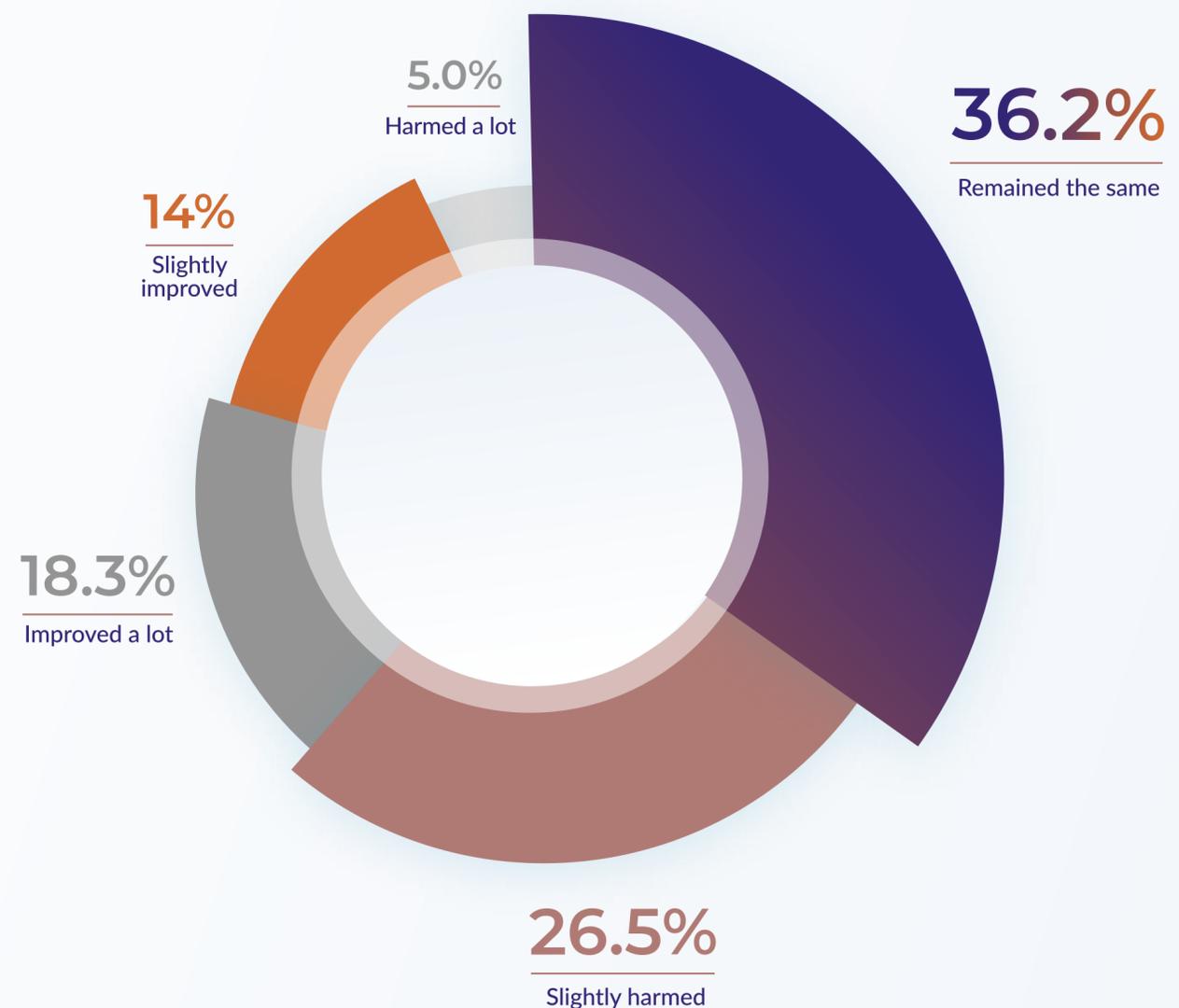
87% of our CTOs saw the amount of remote work in their organization increasing as a result of the pandemic. This speaks volumes of the massive shift that had to occur in how organizations worldwide organize their work since the pandemic began.

Now that the situation has persisted for over a year, we were curious whether increased remote work ended up straining relationships between CTOs and their teams.

The answer is clear based on our data. 68% of CTOs whose amount of remote work increased reported that team relationships were unharmed by more remote work (meaning they either stayed the same or improved). In fact, 18% of respondents whose amount of remote work increased say that the change has improved relationships a lot.

It would appear that our CTOs found a way to keep team relationships strong despite the physical distance.

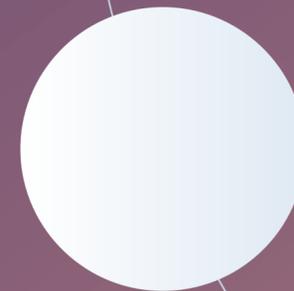
If your level of remote work has increased since the pandemic, how did the change affect your relationship with your team(s)?



06

Hiring

What's important for CTOs
when it comes to recruitment?



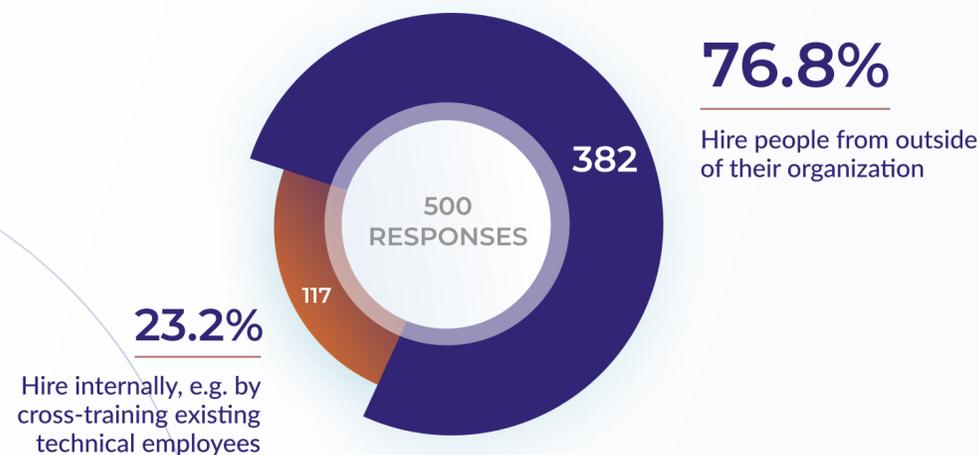
Hiring talent: CTOs want candidates with technical skills and a good culture fit

When looking at our CTOs' career path earlier in this report we discovered that a third of all respondents joined their company as a CTO. This trend of finding talent from outside your organization coincides with the fact that over 75% of CTOs prefer to recruit externally.

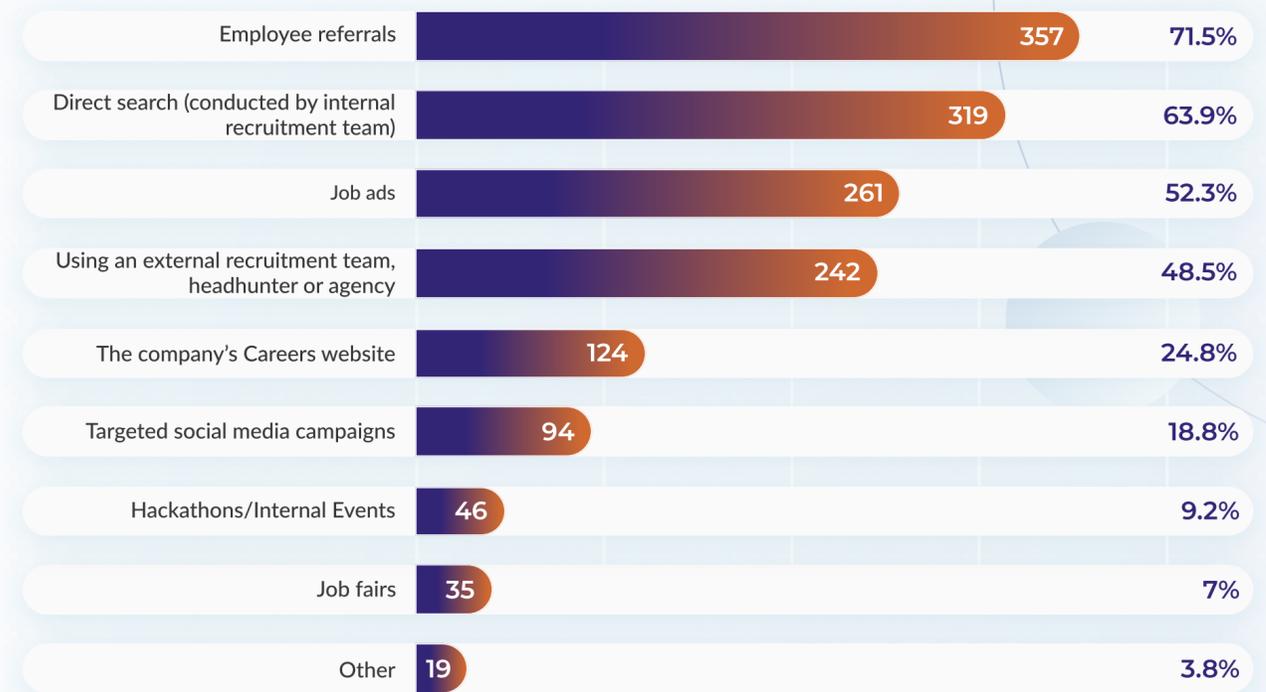
The importance of technical skills is unsurprising when looking to employ within the tech industry. What may come as more of a shock is that being a culture fit is deemed almost as necessary as technical skills. According to respondents, a good culture fit is rated more than twice as important as the number of years of experience a potential colleague has.

The significance of being a good culture fit may go some way to understanding why employee referrals top the chart of most efficient hiring methods; a personal recommendation can tell you more about a candidate's personality and working style than you can get from other recruitment pathways.

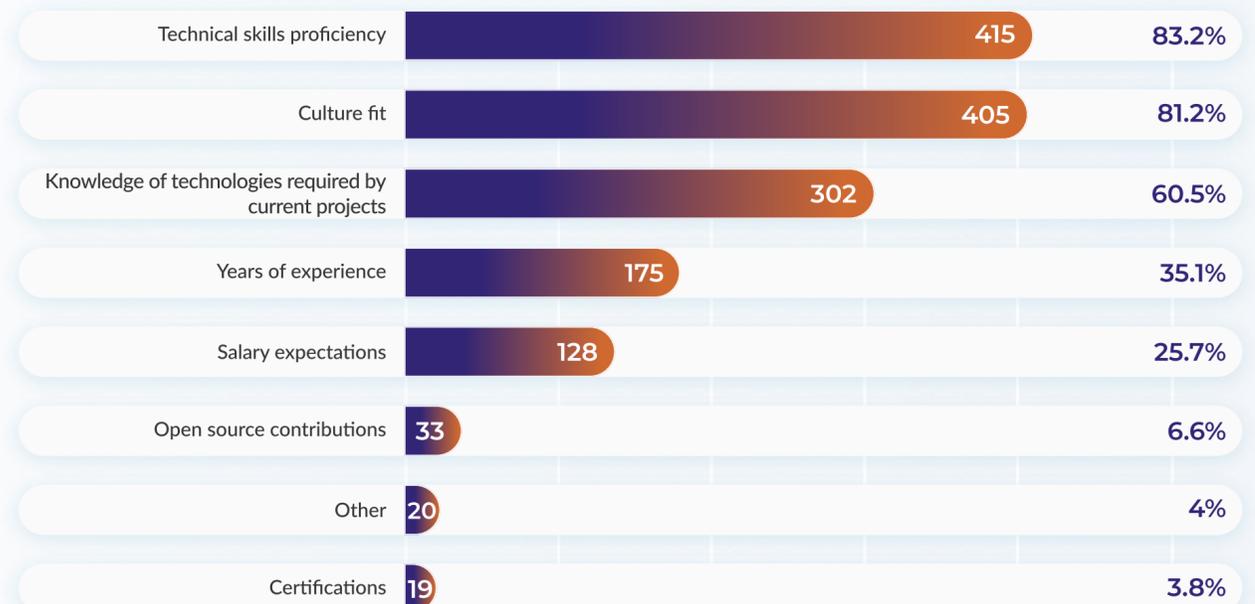
When recruiting, CTOs prefer to:



What are your most efficient methods to hire talent?



What are your most important hiring criteria?



Expert commentary

LIDR

Alvaro Moya

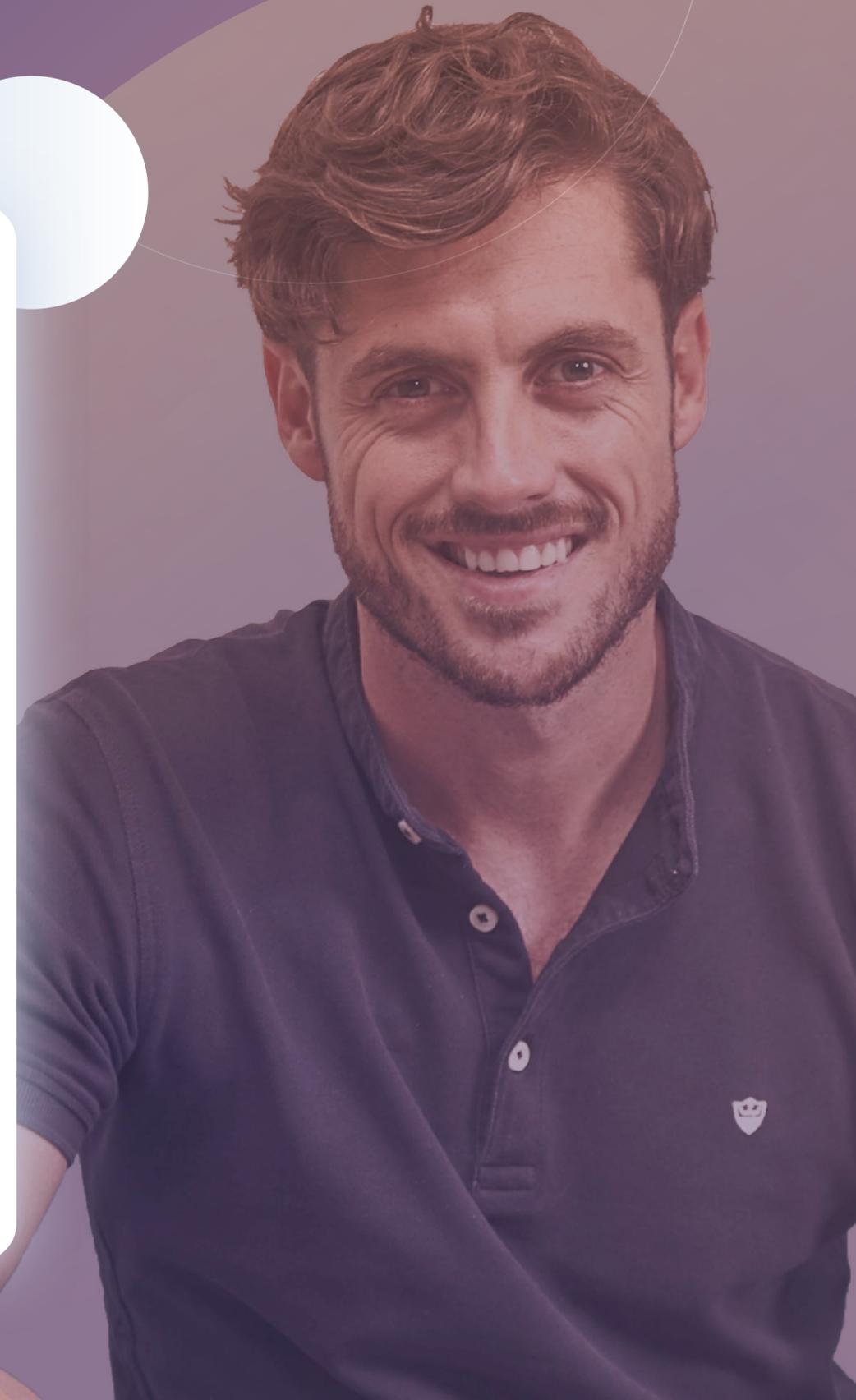
CTO, TECH MENTOR, FOUNDER OF LIDR.CO

For the second year in a row, employee referrals are the most efficient way to hire. Think about it: for candidates, they know exactly what to expect, and they start with connections inside. For the company, candidates are pre-screened and risk is lower.

Yet, only a small percentage of companies take referral systems seriously. Why don't you invest in having a team of potential advocates, and make the relationship a win-win-win?

Let your team own your team, make them co-responsible of hiring, and enjoy the benefits. At Lidr.co we foster that attitude among engineering teams, which helps companies to develop game-changer employee experiences that pay off. Here are some tips:

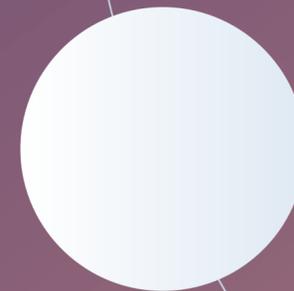
First, find out WHY your team would recommend others to work there, and make sure you excel at that. Some hints: ownership, challenges, sense of belonging, growth. Second, facilitate them to do it with a simple process and a tempting referral bonus. Then measure, learn, adapt and repeat.



07

Training

How do CTOs approach the development and growth of their team members?



Hard skills vs soft skills: which is more important for team members' growth?

When deciding whether hard or soft skills were more important when growing a team, our respondents were split roughly down the middle. Just **over half of the CTOs deemed soft skills as more significant than hard skills** in this instance.

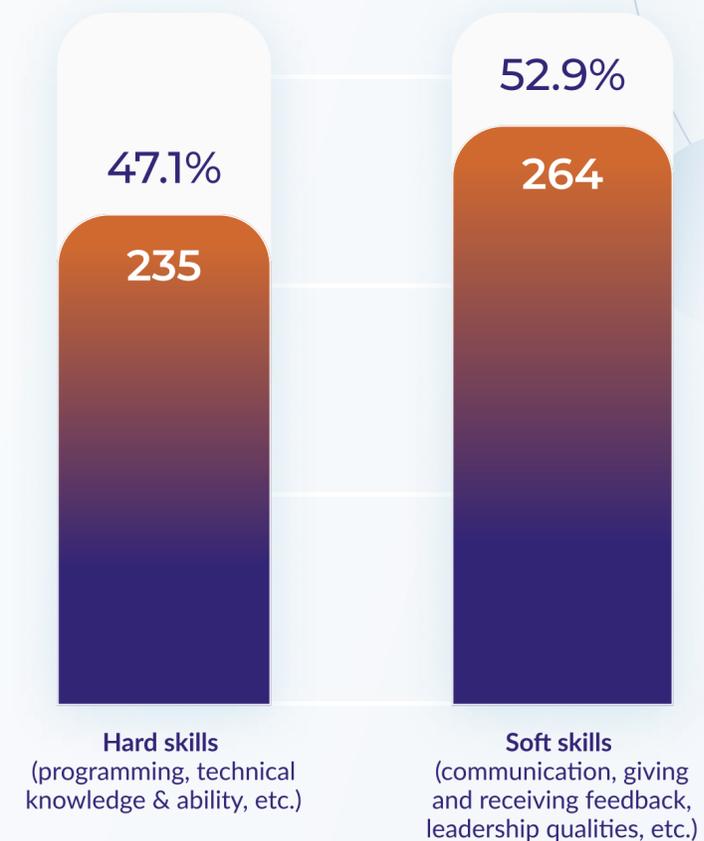
Hard skills are a given for the majority of roles in the tech industry. You would not expect someone to be given the position of software engineer if they lacked the knowledge and expertise necessary to perform their job.

Soft skills are different. And some people who are skilled at their job must work hard to improve areas like communication and time management.

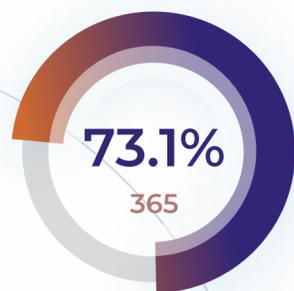
The fact that **52% of respondents chose soft skills as the priority** for team members' growth matches a general trend across industries. According to a LinkedIn report, 89% of employers say that "bad hires" are typically down to a lack of soft skills.

Area of improvement in relation to soft skills may be difficult to identify through a formal process, but there is usually a **clear system in place for spotting technical skill gaps**. 73% of respondents favor **pairing developers/engineers** with more experienced colleagues—and **receiving communication** from the more senior members of the team.

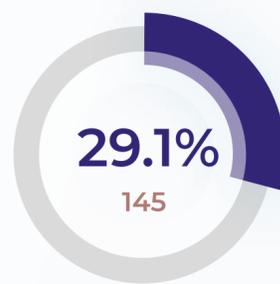
When you're growing your team members, which skills are the most important?



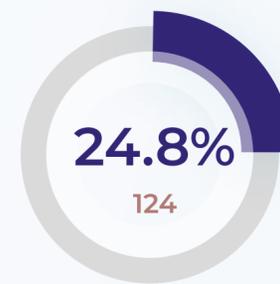
How do you identify technical skill gaps on your team?



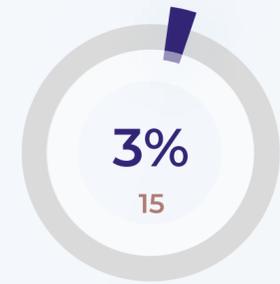
I pair them with a more experienced engineer and rely upon the reports of the senior staff



I ask new employees to troubleshoot a project and find the coding errors



I test new employees by asking them to write sample code



Other

Team members' growth: Technical knowledge is king—but soft skills matter

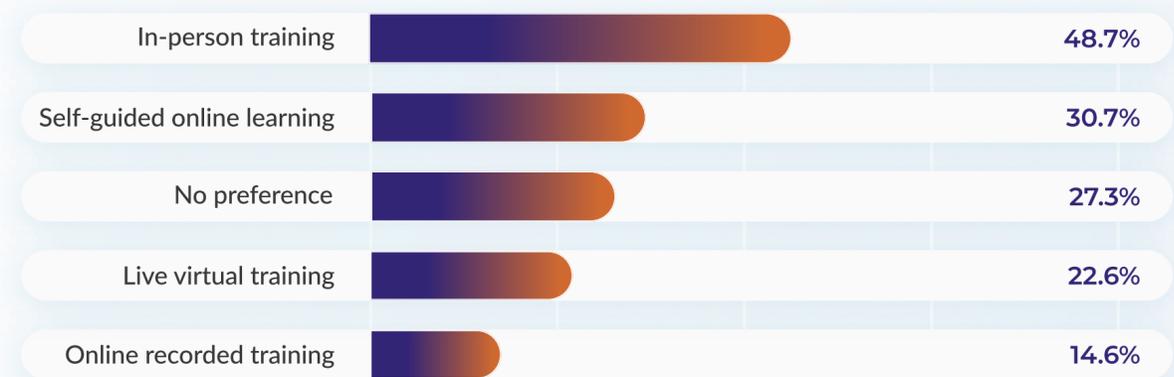
Technical knowledge was deemed the biggest individual factor for employee growth. Perhaps surprisingly, technical knowledge was followed in order of significance by key soft skills: **attitude** and **communication**. When it comes to team members' growth, attitude and communication are thought to be more important skills than **creativity** or **speed of implementation**.

What skills do you deem most important for your team members' growth? Rank them in order of importance.



For companies around the world, in-person training has been difficult—or at times impossible—during 2021. But the CTOs responding to the survey were divided on whether this is an issue for them. Just under 50% of respondents would prefer their teams to undergo in-person training when possible. Meaning that around half of all CTOs in the survey either prefer an online alternative—or have no clear preference.

Once in-person activities are possible again would you prefer your team(s) to attend:



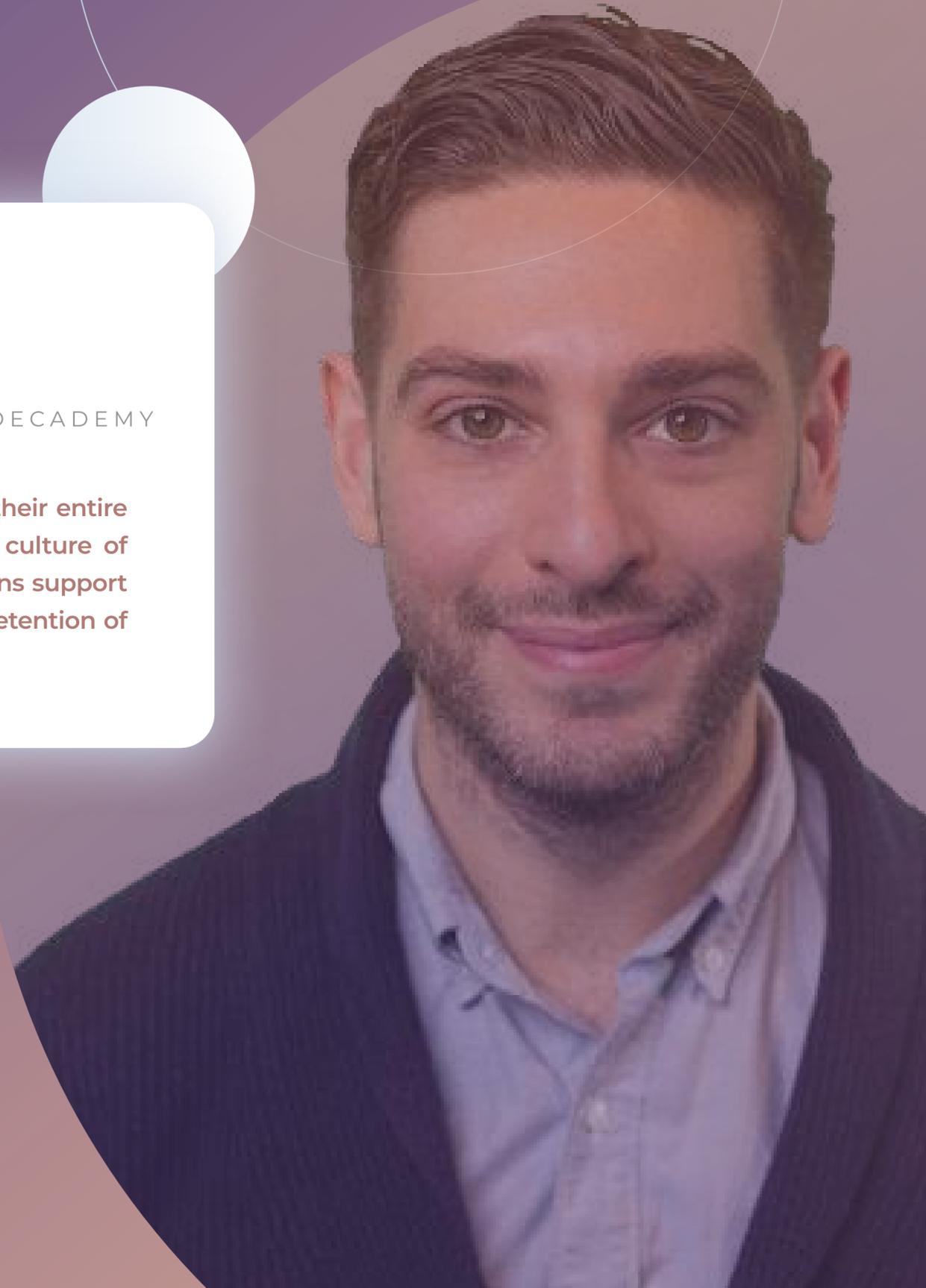
Expert commentary



Jonathan Naymark

GENERAL MANAGER OF CODECADEMY FOR BUSINESS @ CODECADEMY

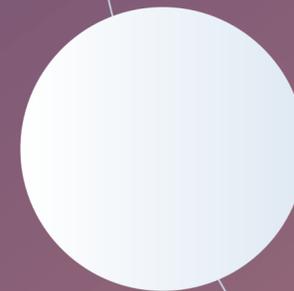
To be successful today, employees will need to learn new skills throughout their entire career trajectories, and the responsibility falls on employers to facilitate a culture of continuous learning. By investing in technical training resources, organizations support their employees' professional growth -- leading to higher engagement and retention of talent -- while also keeping pace with innovation.



08

Challenges

The issues CTOs have
faced in 2021



CTOs' top concerns: Recruitment challenges rise as unemployment drops

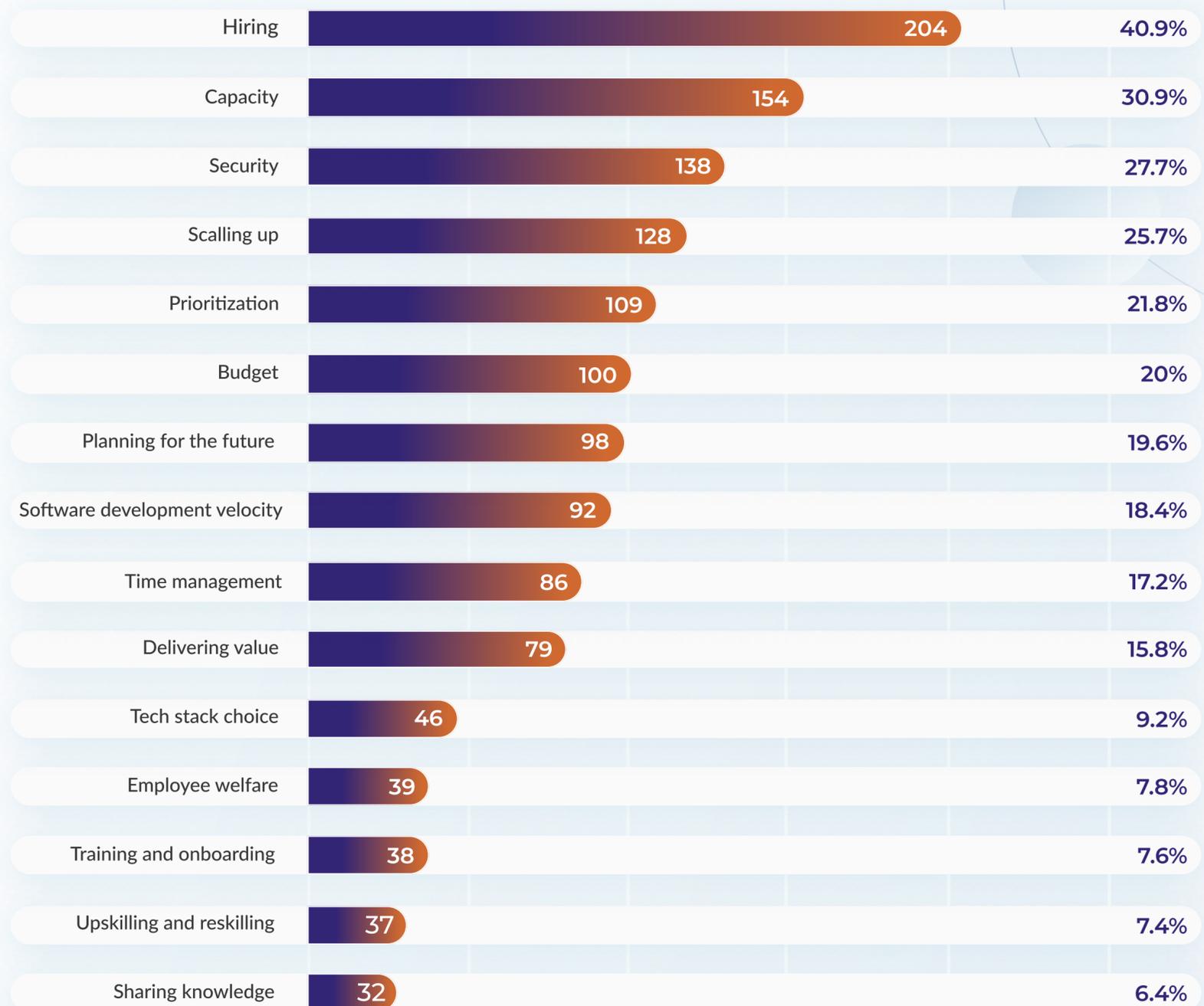
Hiring has proved to be an issue in 2021: a year that has seen falling unemployment rates in the USA, UK, and EU since they peaked during the COVID-19 pandemic. An increase in job vacancies and fewer people out-of-work means that individuals searching for new positions have the upper hand in a competitive job market. The pandemic also accelerated businesses' use of digital solutions and the increased demand for digital technologies which has made IT recruitment particularly hard.

Along with hiring, issues related to staffing and attrition have also been seen as some of the main challenges this year; **capacity**, which was number five in last year's biggest challenges, is now CTOs' second-biggest challenge. **Scaling up** is the fourth-biggest challenge.

Unsurprisingly given the proliferation of cyber attacks in 2021, security is a top-of-mind concern for CTOs as well. And as we know from previous sections of our report, CTOs' concerns about security primarily reflect concerns about human error, which is considered the biggest security risk by our respondents.

Prioritization was named as the biggest challenge in the Global CTO Survey 2020RRT but has now fallen to the fifth position.

What are your biggest challenges right now?



Expert commentary



“
Clutch

Sarah Anyan

PRODUCT MANAGER @ CLUTCH.CO

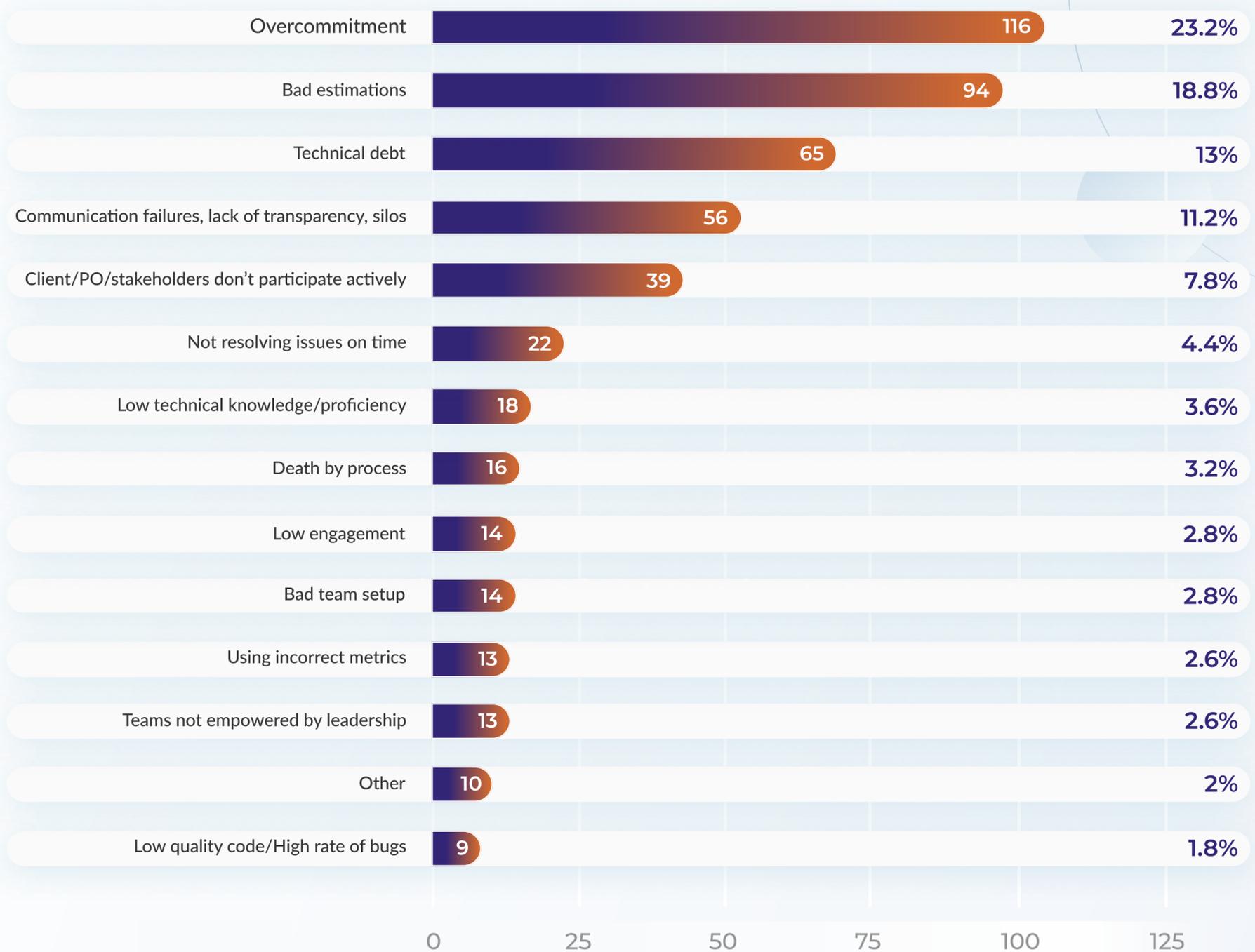
Working with staff augmentation companies to build an outsourced tech team is one option for tackling hiring and capacity challenges at your company. For example, you can use Clutch.co to find staff augmentation companies that integrate with your team and help you meet your tech goals, without hiring all your team in-house.

Time is the key contributing factor to the majority of delivery problems

The three main reasons for delivery problems for respondents' teams are all connected to time management or speed of delivery. Whether issues arise due to taking on too much work, unrealistic time frames, or prioritizing faster delivery resulting in technical debt; time plays a central role in the cause of delivery problems.

The data shows us that gaps in soft skills lead to more delivery problems than those caused by hard skills. For 11% of our CTOs, communication failures/lack of transparency/silos are the number 1 cause of their team's delivery issues. Compare this to low technical knowledge/proficiency (3.6%) or low-quality code/high rate of bugs (1.8%) and it is clear to see that hard skills are not the main problem when it comes to delivery.

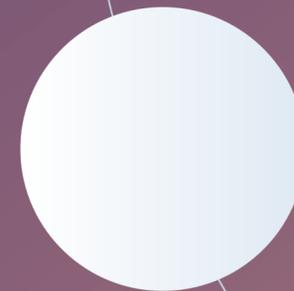
What is the #1 cause of delivery problems for your team?



09

Self-development

A look at CTOs' growth
and areas of improvement

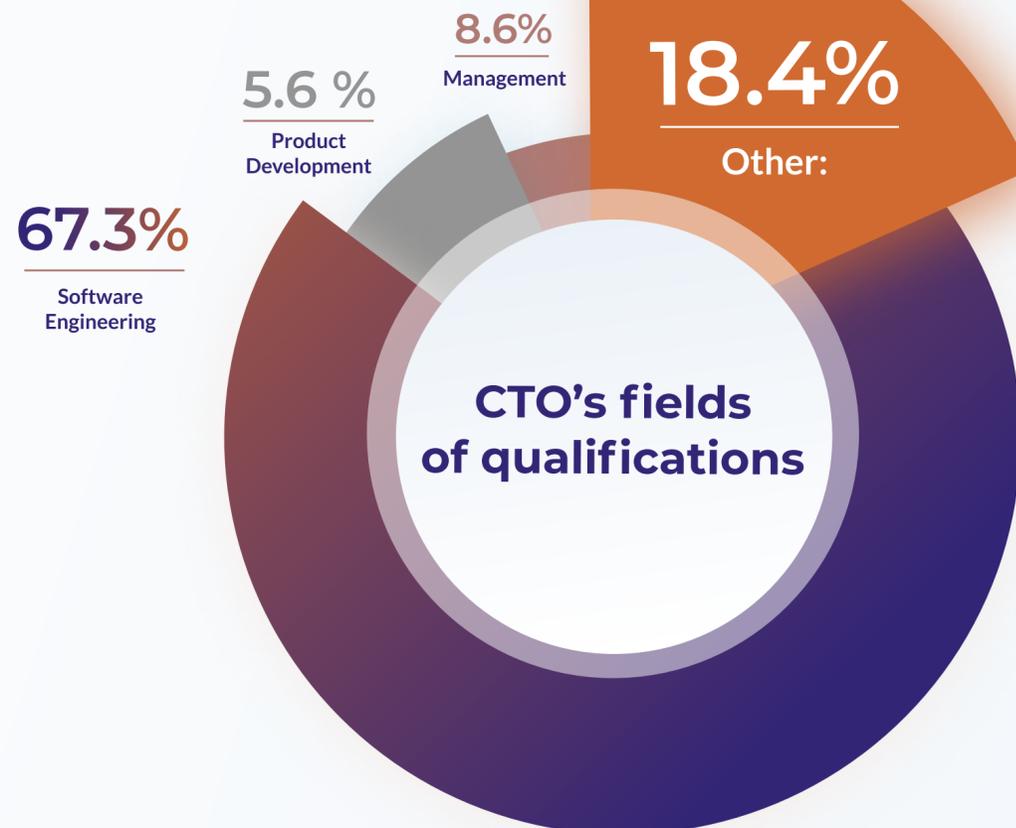
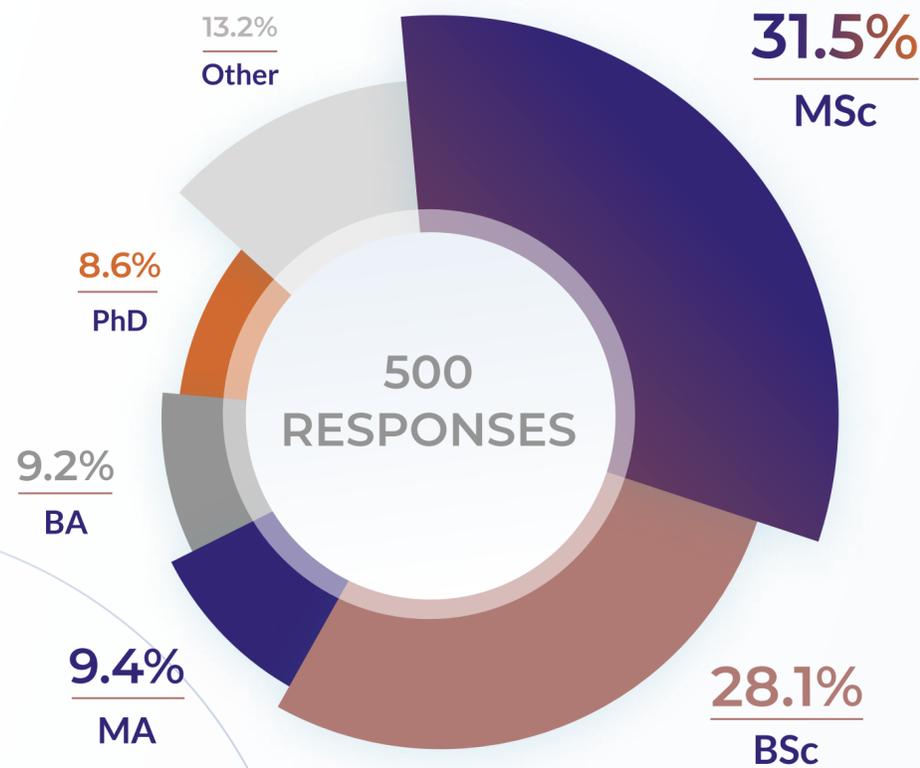


At least 86% of CTOs are educated to a degree-level or higher with Software Engineering being the most popular subject to study

We have already noted that almost 70% of respondents have previously worked as a software developer/engineer before becoming a CTO—and 64% of our CTOs learned programming at university; so it comes as no surprise that two-thirds of our CTOs have a qualification in software engineering. Postgraduate studies are popular amongst respondents with 18% holding a Ph.D. or MA qualification.



What is your current level of qualification?

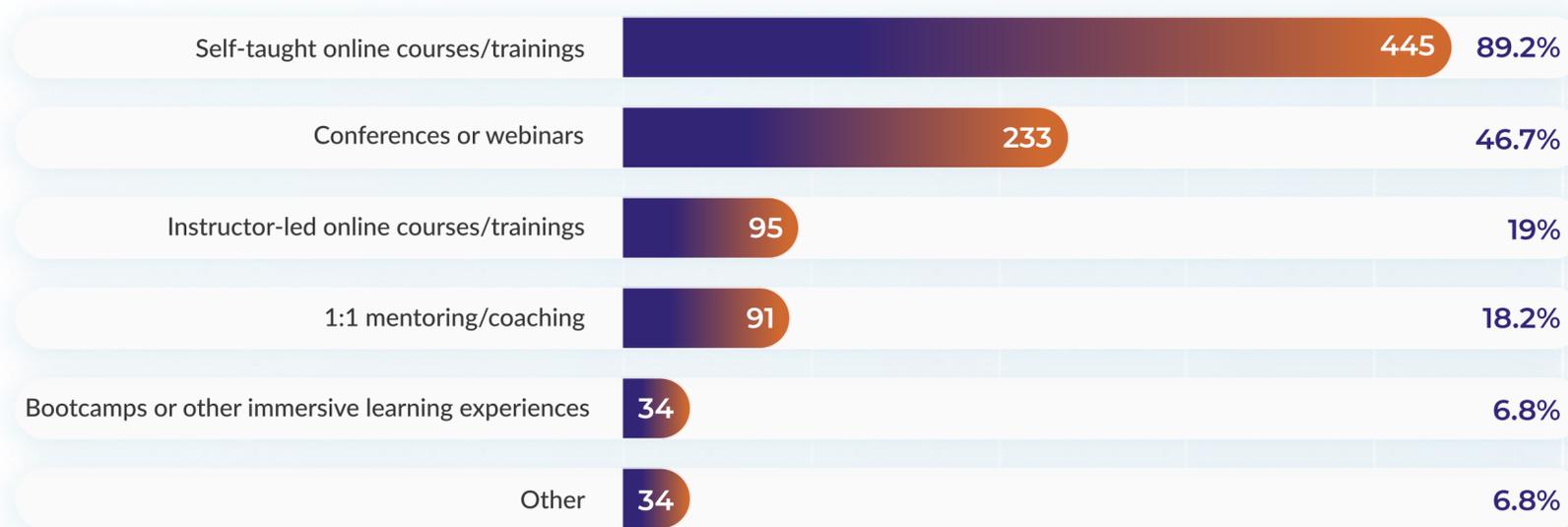


97% of CTOs dedicate time to education on a weekly basis; 19% spend over 400 hours a year learning

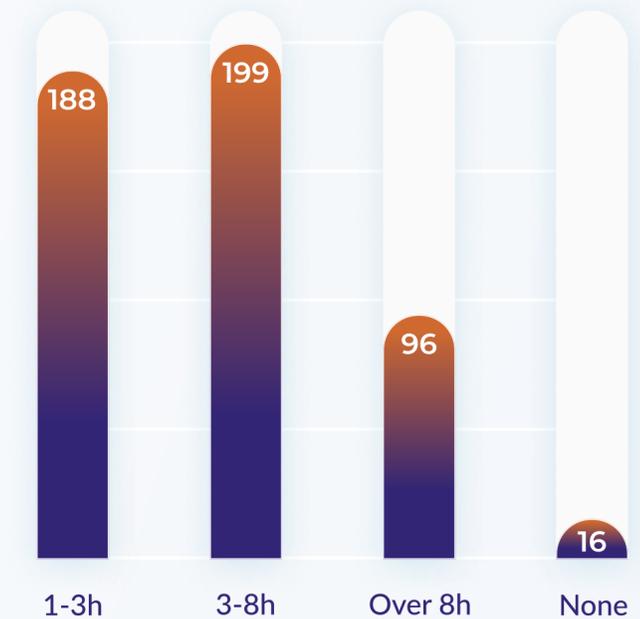
Only a very small percentage of respondents claimed to not dedicate time to learning on a weekly basis (3%). Around 1 in 5 of our CTOs spend over 8 hours learning each week. This equates to over 400 hours annually.

Although we cannot say for certain if this education takes place within “office hours” or is done outside of work, one thing is for sure: self-taught online training or courses are by far the most popular method of study with 89.2% learning in this way.

How are you learning?



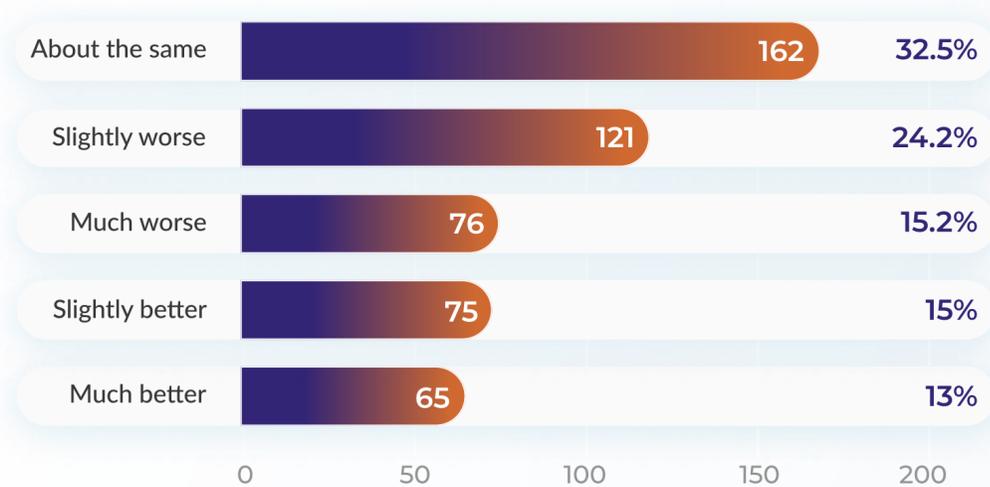
How much time do you spend on learning weekly?



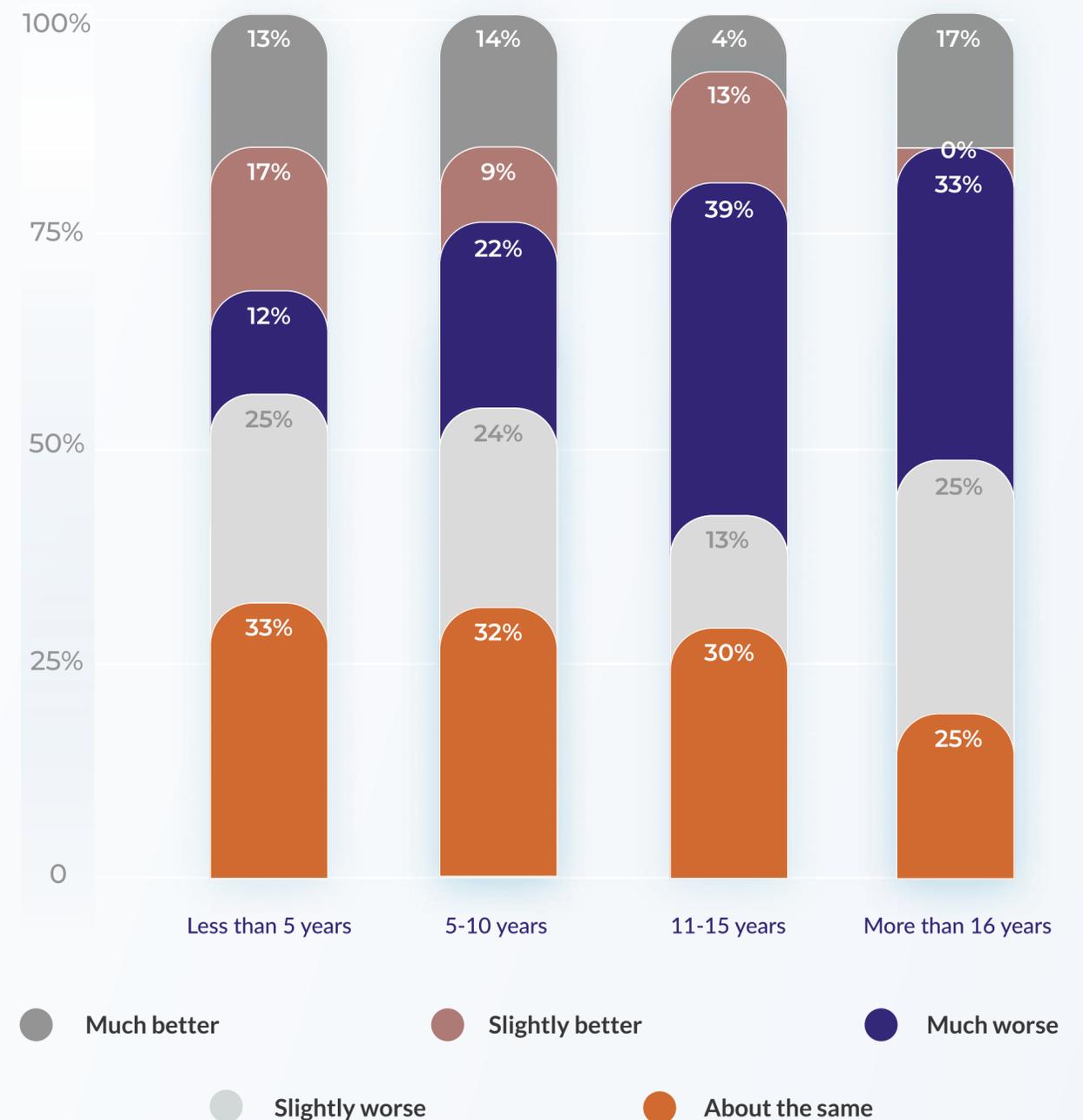
More experienced CTOs believe their coding skills have worsened

When it comes to coding, less than a third of CTOs see their personal skills improving since they took the position. **39% of respondents believe their coding abilities are getting worse.** There is a link between the length that CTOs have held the position and their individual coding skills; **the longer someone has been a CTO, the less likely it is that their abilities at coding will have improved.**

Since becoming CTO, would you say your personal coding skills have become better or worse?



Personal coding skills vs years as CTO



75% of CTOs haven't completed a cybersecurity course

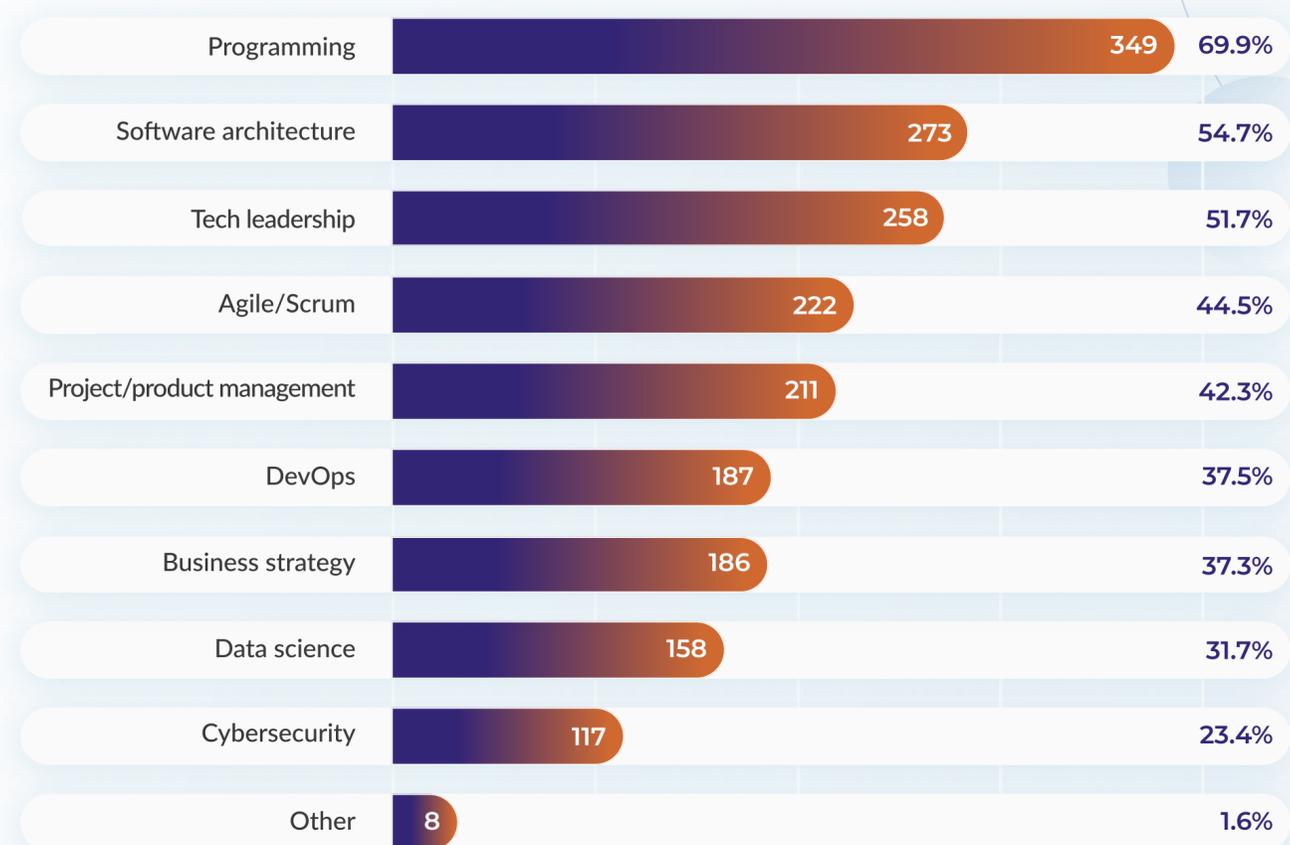
CTOs are expected to have taken courses to improve their technical skills—and many of our respondents have—but interestingly, 44% of all courses taken by our CTOs actually related to **business/management** (tech leadership, agile/scrum, project/product management, business strategy).

Just over half of the CTOs completed a course specifically about **tech leadership**, which suggests that 50% of all CTOs decided that "learning by doing" is not enough to become a great tech leader and that formal training is also required.

2021 has seen cybersecurity threats rising—and they've been predicted to increase. This is clearly a significant concern for CTOs and their organizations. In last year's survey, 38% of respondents named **cybersecurity** as one of their top priorities. Yet, **three-quarters of respondents have not completed a cybersecurity course**. It will be interesting if the number of CTOs taking cybersecurity courses increase over the next few years.

By the way, if you're a CTO and have completed a course on **business strategy**, **DevOps**, or **data science**—congratulations. You're ahead of a lot of your peers.

What courses have you completed?



19

Leading by example: the areas CTOs want to improve

It is worth comparing the insights we've already learned in previous sections of this report against the areas in which CTOs want to improve.

52% of respondents deemed soft skills key to team members' growth. Similarly, **CTOs want to develop their own soft skills**. Two of the biggest areas for improvement were **managing people** (35%) and **communicating with stakeholders and reports** (21%).

By working on their soft skills, CTOs would be setting a clear example to other team members. **Displaying leadership and navigating their team in the right direction** is clearly important to respondents of the survey; 26% of CTOs chose **defining the long-term vision** as an area of self-improvement whilst 19% would like to work on **fostering the desired culture, attitude and behaviors into the team**.

Hiring people was ranked as the single biggest challenge that CTOs face at the moment. However, it is in sixth place when it comes to areas for improvement. This may be due to the fact that some CTOs see recruitment issues as a widespread problem across the industry that cannot be easily solved by an individual upskilling themselves in this area.

2 out of 3 respondents thought that their coding skills had either remained the same or had actually gotten worse since becoming a CTO. So it comes as no surprise that the fourth most important area of growth for CTOs who took part in the survey was **improving their overall tech skills**.

Which of the following areas would you like to improve the most in?



Expert commentary



Andrew Weaver

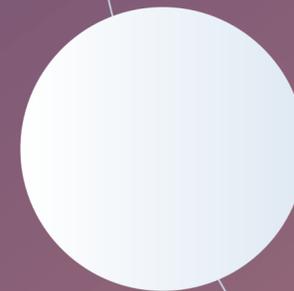
CEO AND CO-FOUNDER @ CTO ACADEMY

Really encouraging to see this increasing awareness and focus on building the softer people skills which ultimately make such a difference at CTO level. My only note of concern is the high percentage of CTOs anxious about **improving their tech skills**. I'd have preferred to see that replaced with as time-poor CTOs need to deliver their value in higher impact areas of the business.

10

Satisfaction

How satisfied are CTOs with their jobs, teams, and software velocity?

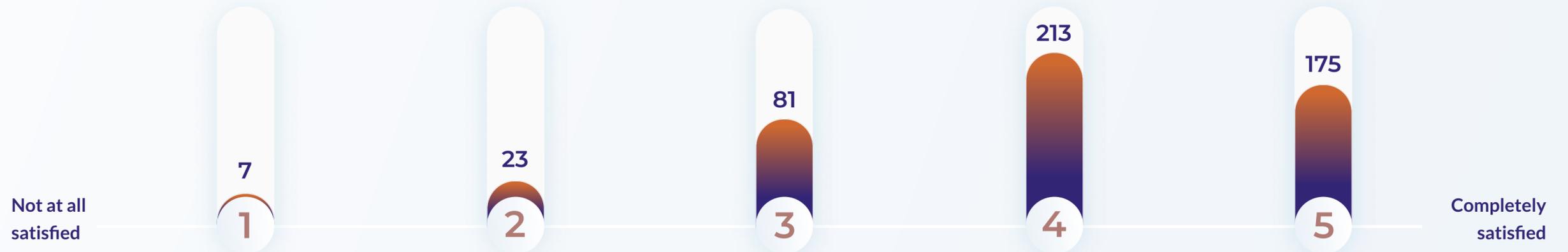


Overall job satisfaction for CTOs has risen in 2021

Job satisfaction is generally high among CTOs in the survey; the average rating being 4.1 out of 5. This is a rise from last year’s survey which was 3.94 out of 5. Over three-quarters of respondents chose one of the two highest categories with 35.1% of respondents to this question saying that they were “completely satisfied.”

Salary satisfaction does not rate as highly as job satisfaction. Although, with the average rating being 3.4 out of 5, CTOs in general are leaning more towards feeling satisfied with their salary.

How satisfied are you with your job overall?



How satisfied are you with your salary?



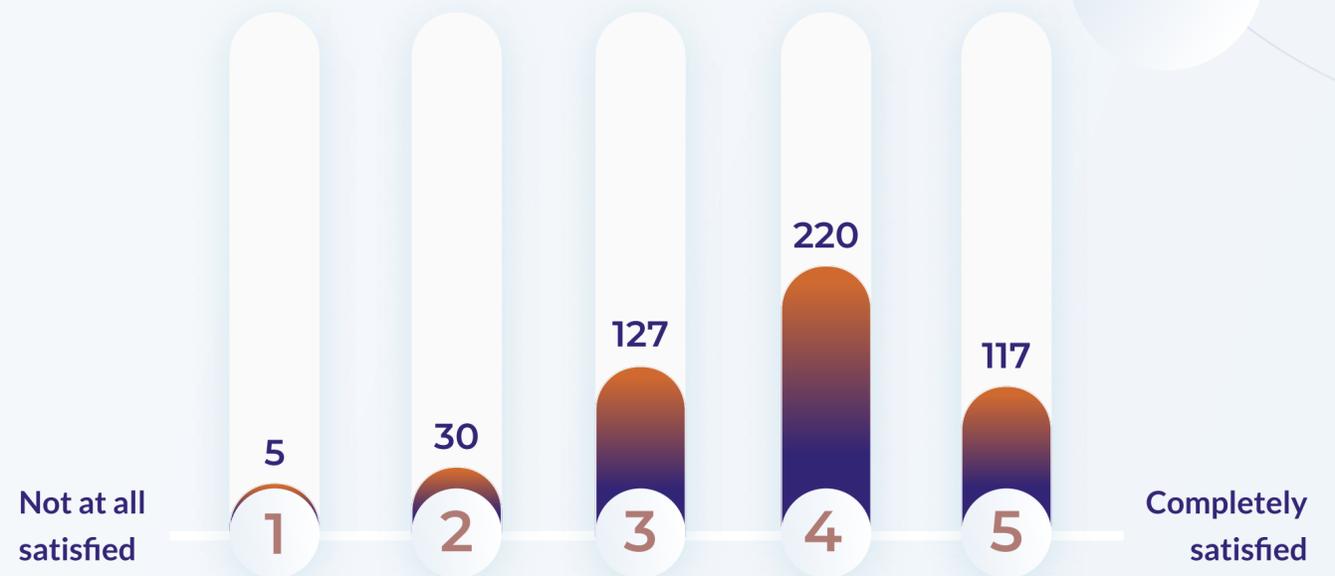
Most CTOs are satisfied with their team—but there’s room for improvement

When assessing CTOs’ satisfaction with their teams, initial observations are **mainly positive**. Only a small proportion of respondents are dissatisfied in this area. Yet, while over three-quarters of CTOs did not claim to be **completely satisfied** with their team, there’s still the **potential to improve** for the majority of teams.

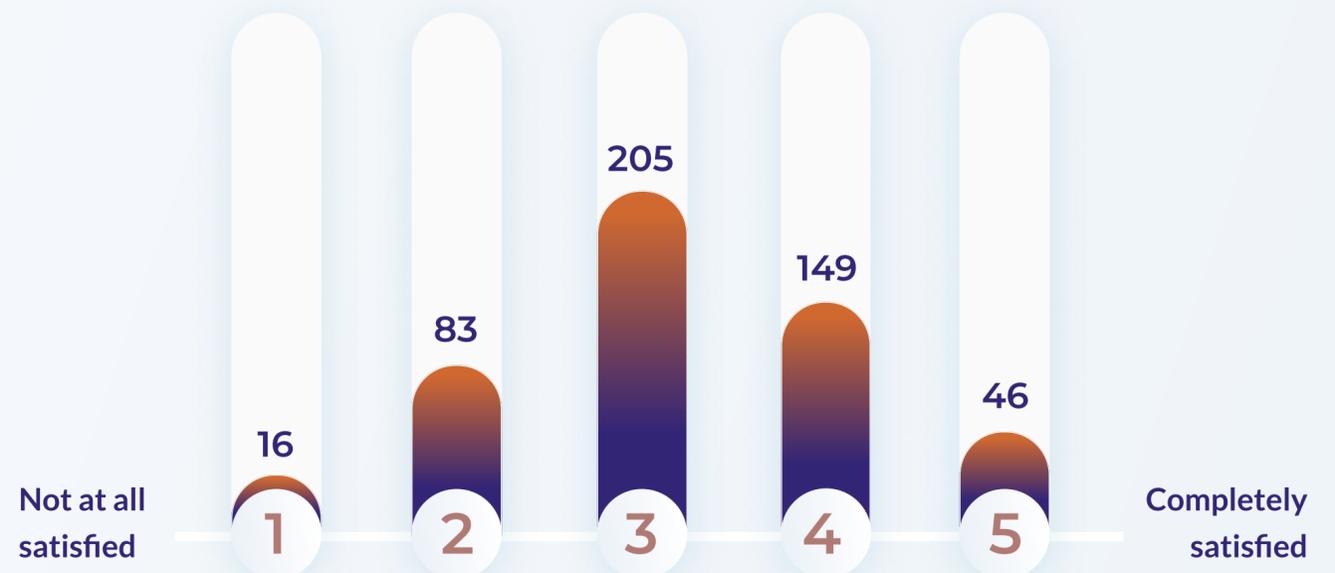
Overall team satisfaction takes into account a number of factors; performance, culture fit, attitude, technical skills, and more. **The satisfaction rating is reduced when we focus on measuring team performance.** There is a much more even split between respondents being satisfied or dissatisfied with software development velocity with most CTO’s (41%) landing in the middle.

This means that **it’s possible for a CTO to be satisfied with their team whilst being less than happy with their software development velocity.** One thing is for certain, software development velocity has plenty of scope for improvement.

How satisfied are you with your team?



How satisfied are you with your software development velocity?

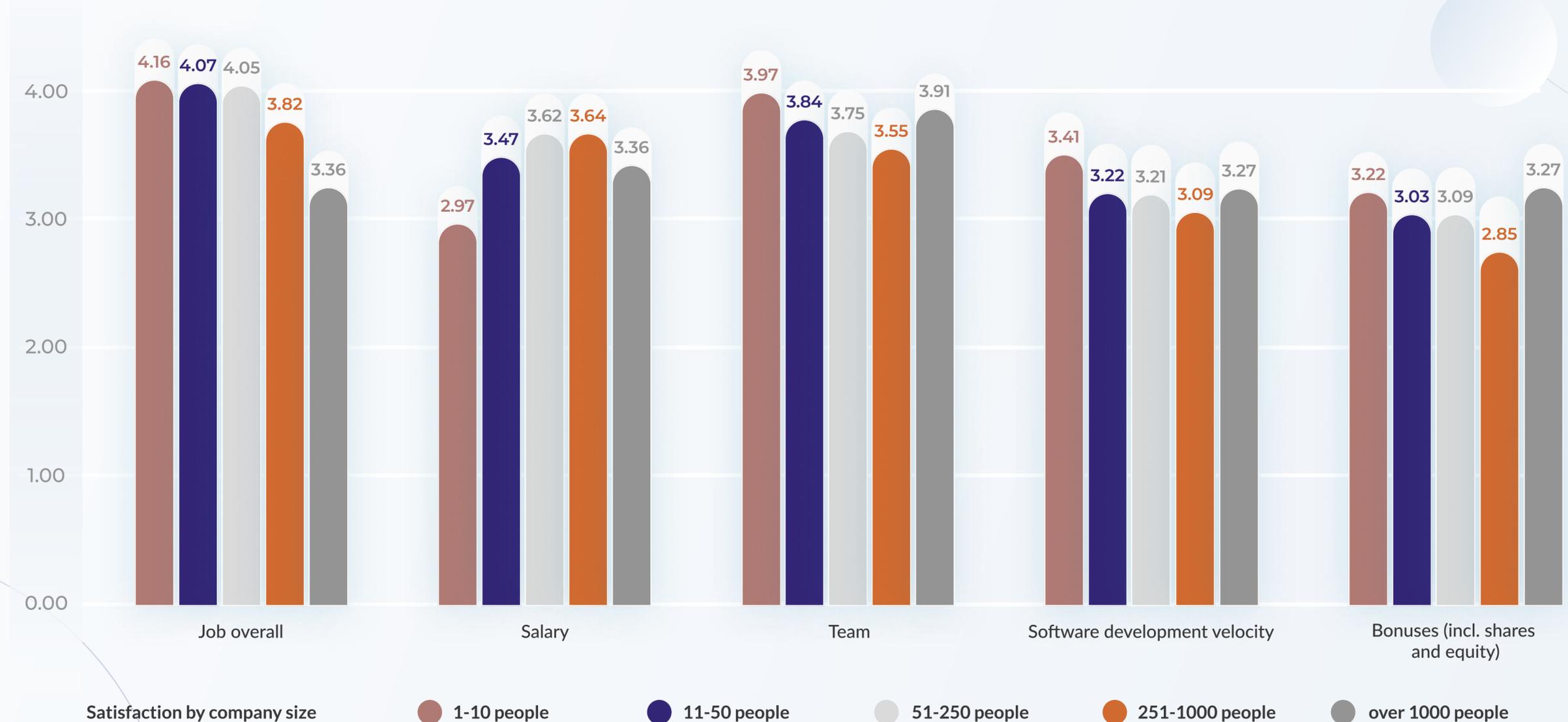


Smaller companies reward CTOs with job satisfaction

When it comes to job satisfaction, organizations with up to 10 employees score highly across the board—bar one key area: salary. It comes as no surprise that smaller companies cannot match the salaries of larger organizations, however, CTOs working at small—or even micro—enterprises rated their satisfaction with bonuses as high. This may be because these bonuses include shares and equity that start-ups or other small businesses may be willing to offer their employees.

Overall, job satisfaction correlates with company size; the smaller the organization, the higher the job satisfaction rating on average.

How satisfied are you with your...



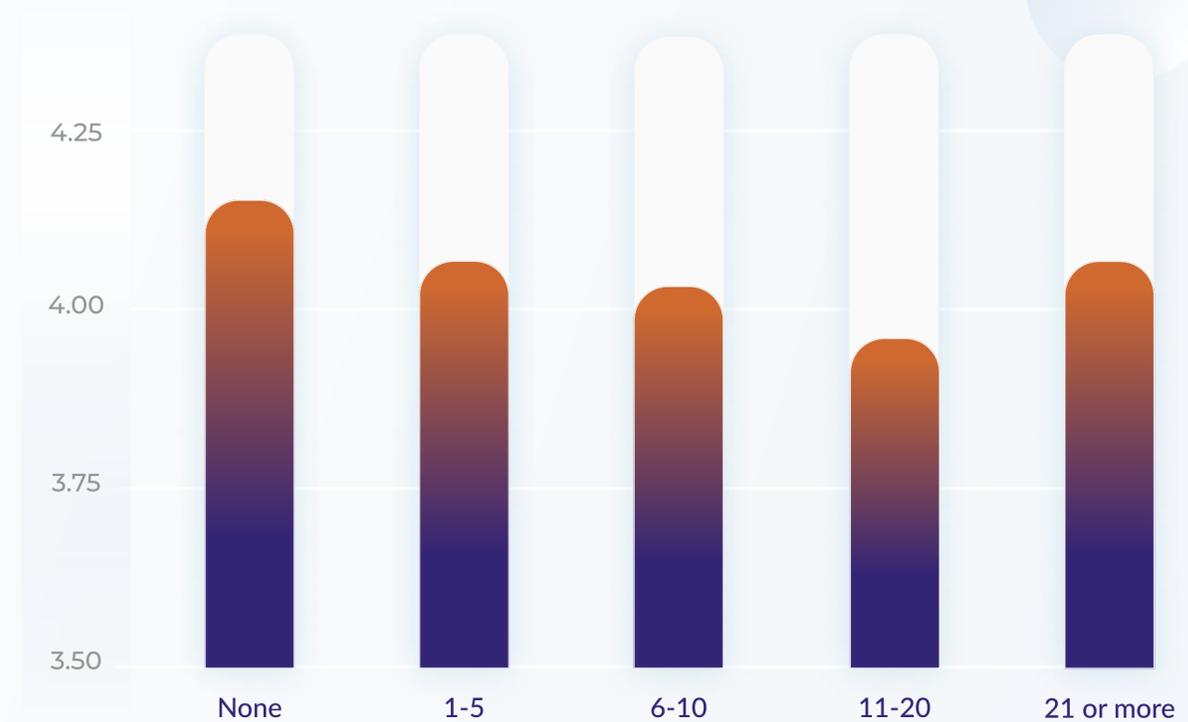
The burden of management can impact job satisfaction—unless you're leading a very large team

It seems logical that CTOs with many team members reporting directly to them might be more stressed and less satisfied with their job—but does the data confirm it?

The survey results in this regard are particularly interesting. **CTOs with no direct reports were indeed the happiest**, and with more direct reports their average job satisfaction rating went down slightly. But there's a twist: **CTOs with more than 20 direct reports were the second happiest category.**

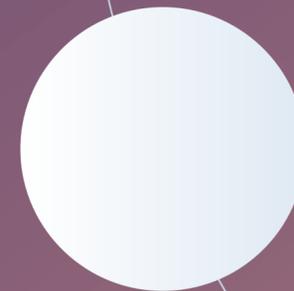
One possible explanation for this might be that CTOs with very large teams let their team members self-organize and support each other to such an extent that managing the whole team actually becomes easier.

Job satisfaction vs amount of team members reporting to the CTO



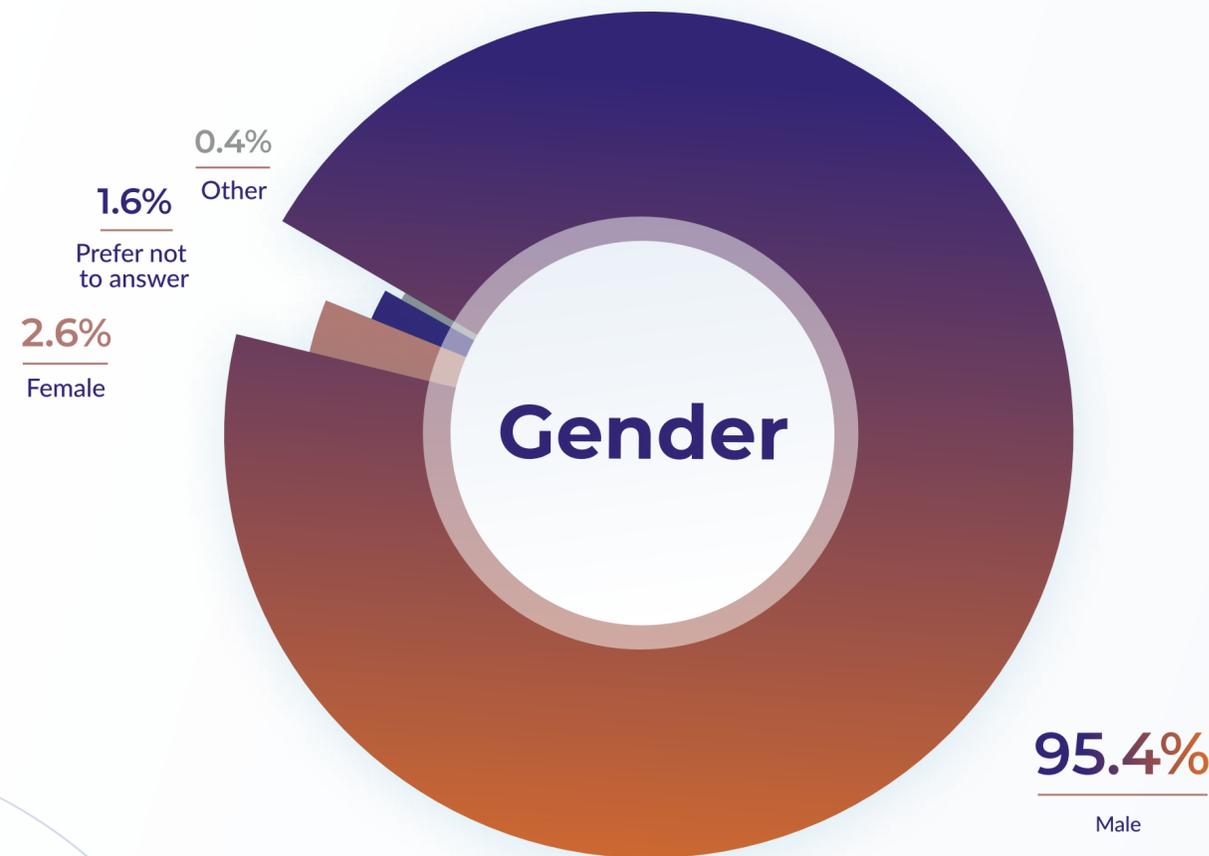
Demographics & firmographics

Who were the individuals
and organizations that made
this survey possible?

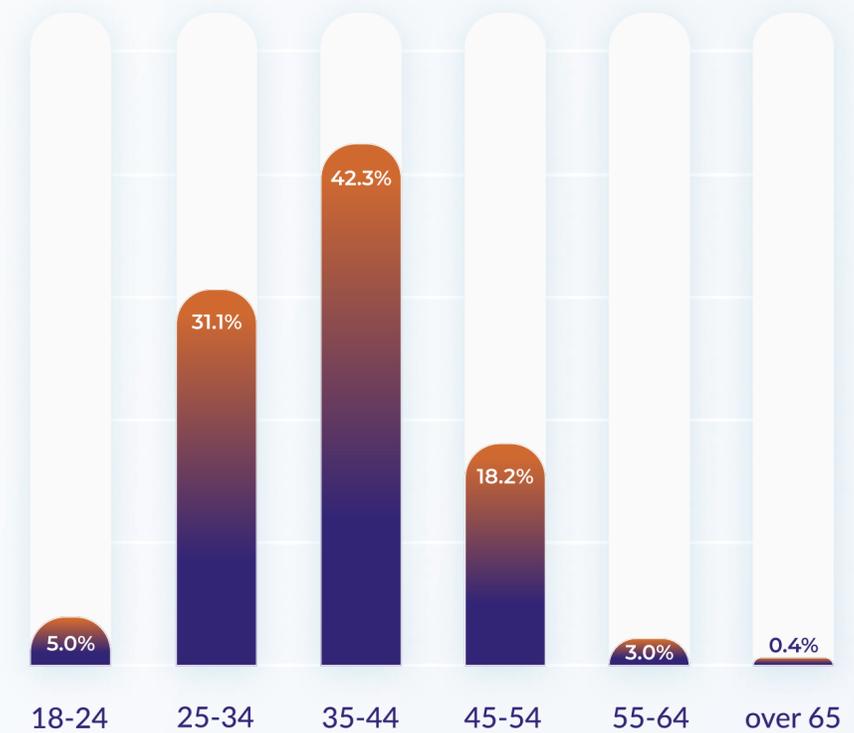


Women do not receive adequate representation in CTO roles

The vast majority of respondents in this year’s survey were male. This is seemingly **not representative of the overall tech industry**; Human Resources in Science and Technology (HRST) reported that **women make up around half of the workers in science and technology in the EU** and a 2020 study by the AnitaB.org Institute found that **28.8% of the tech workforce in the US are female**. Although the proportion of women working in technology is growing, we can draw the conclusion that when it comes to holding CTO positions—females are still vastly underrepresented.



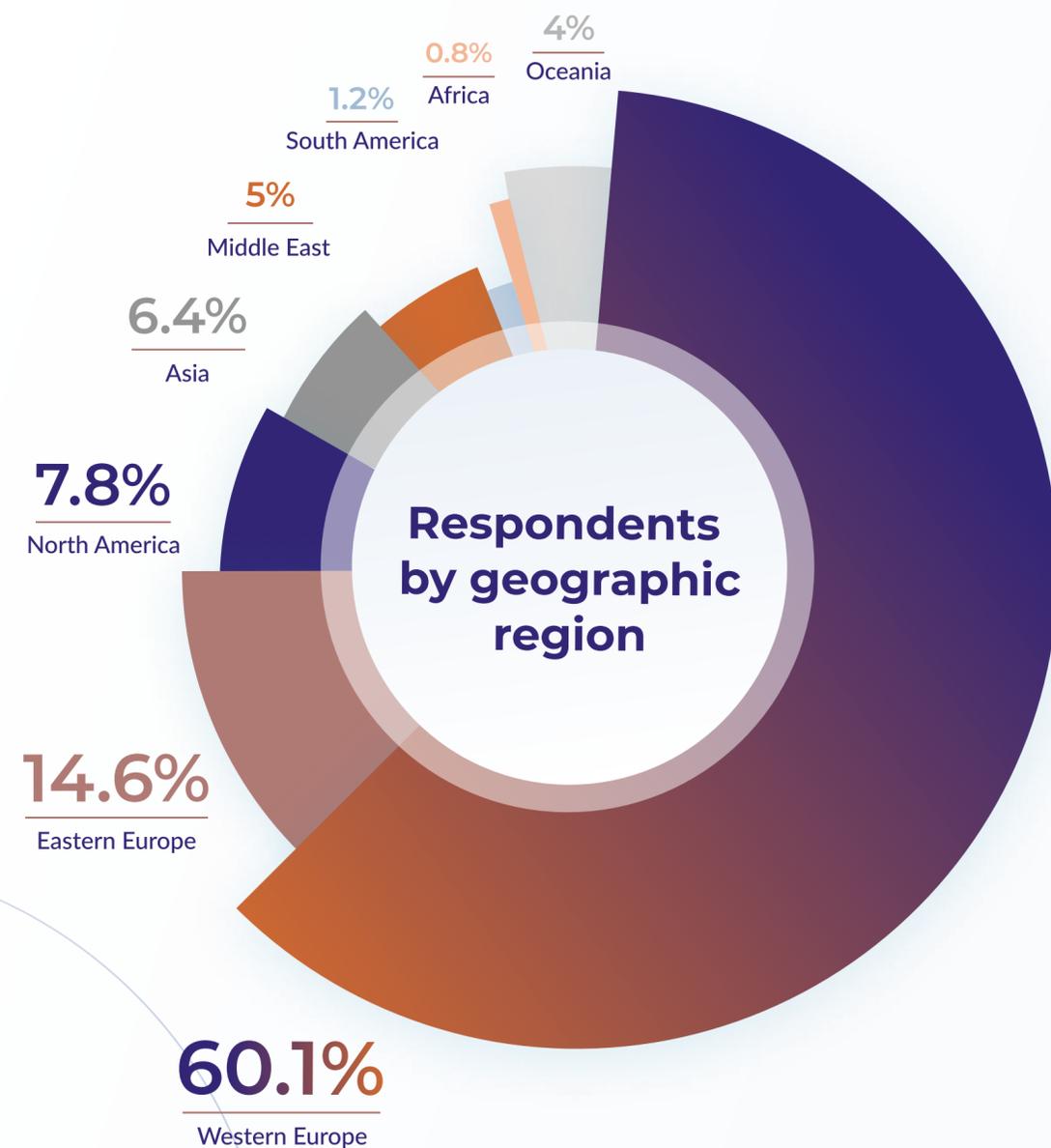
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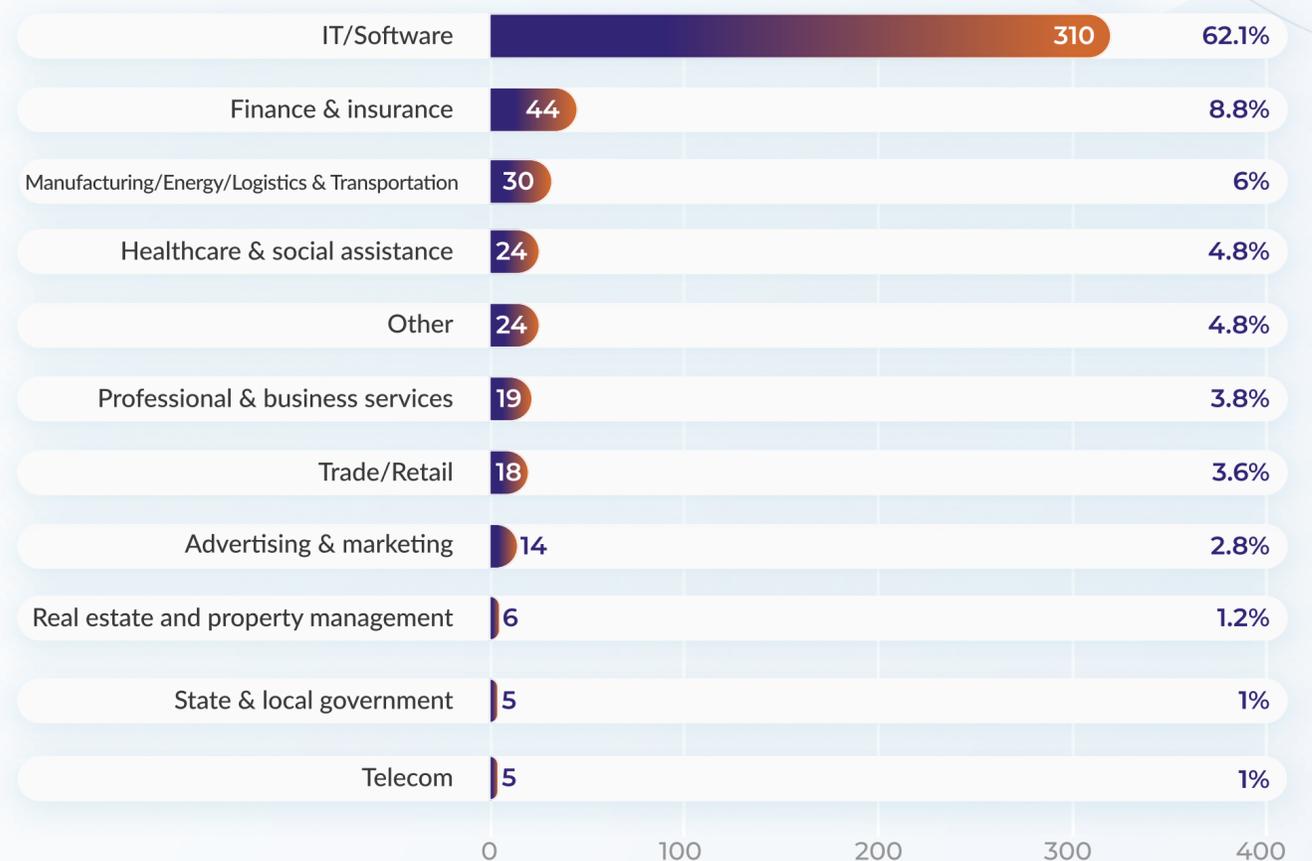
Strong representation for Europe and the IT/software industry in this year's survey

This survey has always been intended to be an examination of the current climate for CTOs globally and we're pleased to see respondents from all across the world. Europe was the best-represented continent (75%) with the majority of respondents being from Western Europe.

For a second year, the majority of respondents come from the IT/software industry; this has actually risen from 49% to 61%. Finance and insurance remain our second most well-represented industries.



Our respondents work in the following industries:



The majority of respondents' companies employ a high percentage of IT staff and dedicate a huge amount of their budget to IT

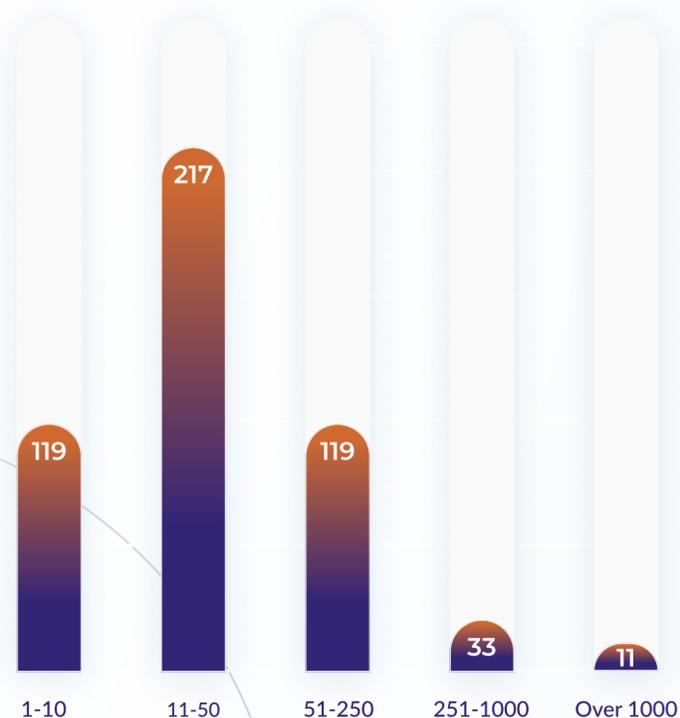
Because two-thirds of our CTOs work in organizations in the IT/software sector, it is unsurprising that large amounts of resources (staffing and budgetary) within these companies are dedicated to IT.

75% of all our CTOs' companies employ up to 30 IT staff.

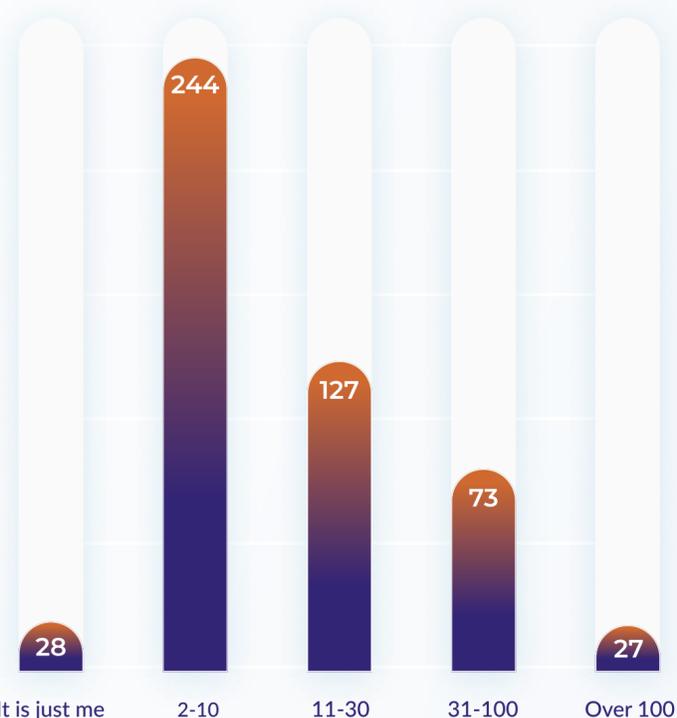
30% of our respondents work at companies where upwards of 45% of the overall budget is earmarked for IT.

It is interesting to note that almost a fifth of our CTOs (18%) are unaware of how much their organization's budget is set aside for IT. For a position that is responsible for developing technology and increasing an organization's profits, this amount is startlingly high.

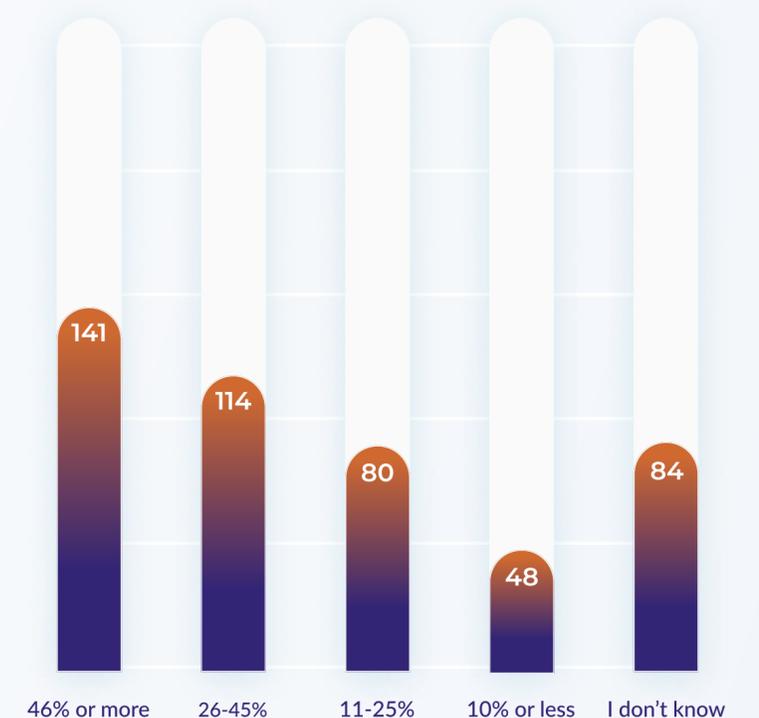
What is the total estimated number of employees working at your organization?



What is the total estimated number of IT staff working at your organization?

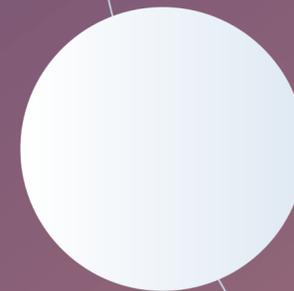


What is the percentage of your overall company budget earmarked for IT?



Credits & acknowledgments

The partners who helped
make the survey a reality



A huge thank you to all our partners

The Global CTO Survey 2021 was made possible with the support of our partners. We would like to show our appreciation to everyone who shared insight through expert commentary, helped to promote and publicize the survey, and offered promotions to our survey respondents.



About STX Next

Launched in 2005, STX Next has grown into the largest Python software development company in Europe.

We provide external talent to software projects. We do this by adding developers to in-house staff or organizing a fully autonomous team to work parallel to a company's developers.

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With the help of internal talent and our partners, we also share knowledge on programming, design, managing complex digital projects, and succeeding as a technology leader. The Global CTO Survey 2021 is part of that effort.

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Expert commentary

Maciej Dziergwa

CEO @ STX NEXT

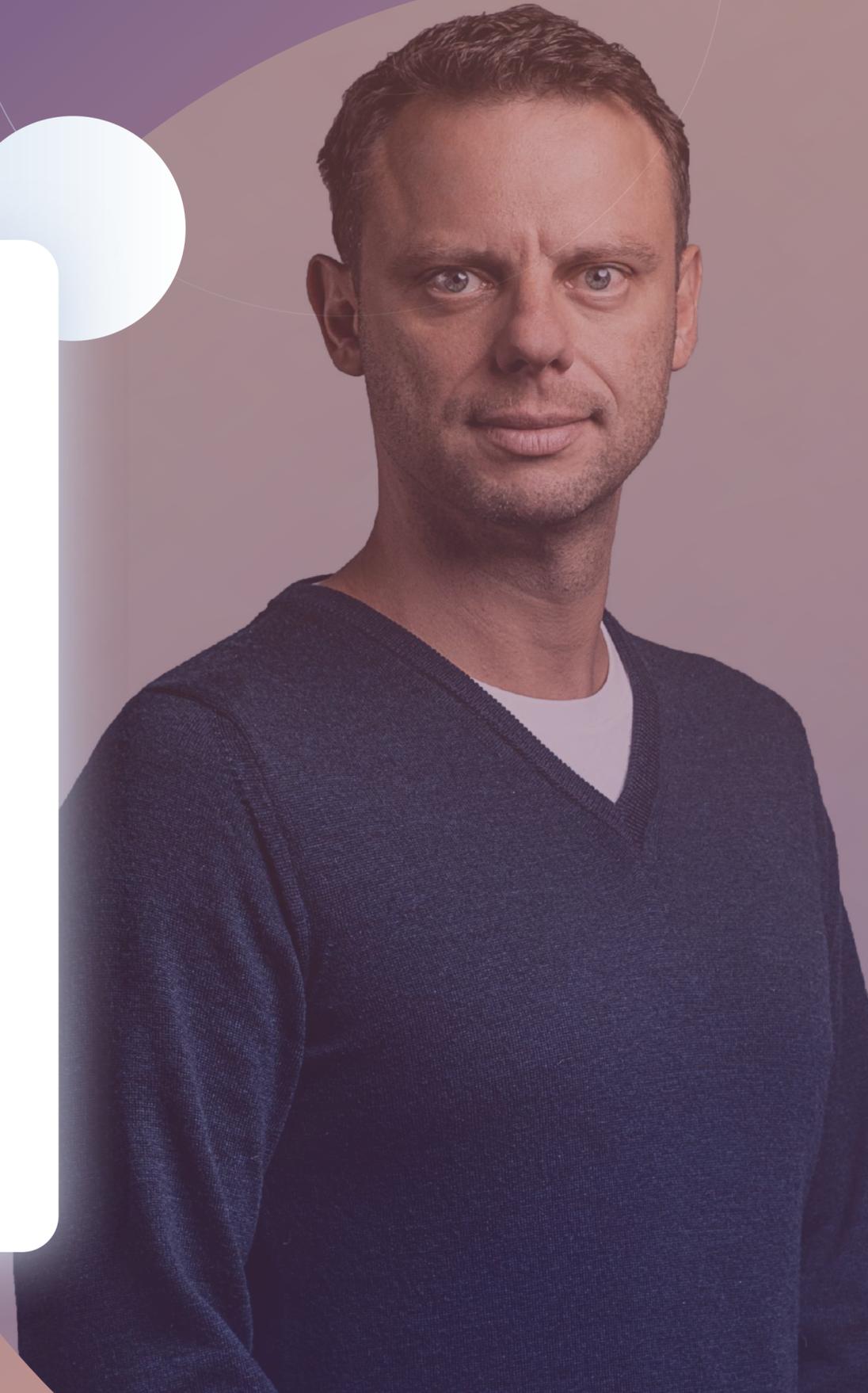
The biggest change in the report compared to last year is the new #1 challenge for CTOs: hiring.

I think a lot of our readers won't be surprised by this; 2021 is the year when developers became more in-demand than ever before.

We see this at our client's companies and we feel it when talking with new prospective clients: businesses need programmers.

That puts a lot of pressure on CTOs, who now need to focus both on keeping high quality talent and attracting fresh blood—while still keeping in mind innovation and making the right tech decisions.

But looking at it another way, the scale of hiring in IT is an indication that tech is growing extremely fast. It will be exciting to see what savvy CTOs will do in 2022 to win in this expanding market. I believe that reading our report will give them valuable intel on where to focus their efforts.



THE GLOBAL CTO SURVEY

See you next year!

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