OpenLogic by Perforce + open source initiative®

The 2022 State of Open Source Report

Open Source Usage, Market Trends, & Analysis

Executive Summary

The 2022 State of Open Source Report from OpenLogic by Perforce and the Open Source Initiative (OSI) provides data on the most popular open source technologies used today, and sheds light on the benefits and barriers organizations experience when adopting open source software.

The report covers the most important open source software technologies used today – including everything from infrastructure technologies and programming languages to DevOps tooling and Artificial Intelligence technologies.

Beyond technologies, the report looks at open source maturity and strategy indicators that provide insight into the trajectory of open source and broader technology strategies for organizations around the world.

Foreword

Dear colleagues,

I'm delighted to welcome you to the 2022 State of Open Source Report – a collaboration between OpenLogic by Perforce and the Open Source Initiative (OSI).

In planning this year's edition, we set out to reassess and improve every facet of the report. We found new ways to ensure we attracted respondents from all regions, organization sizes, and industries. We re-inspected our survey and found ways to make it more representative of not only open source technology adoption, but the planning, strategy, and community contributions that mark organizational open source maturity. Most importantly, we discovered a way to make the report more aligned with the collaborative spirit of open source.

By collaborating with OSI Executive Director Stefano Maffulli on this year's report, we were able to launch a more complete survey, and one that succeeded in better representing those working with open source software around the world. In the six weeks the survey was open, we drew 2660 respondents from every corner of the globe. The data from those respondents has formed what we truly believe to be an unparalleled view into the state of open source software in 2022.

There are some familiar stories. The first being that open source adoption is continuing to expand. In 2021, 77% of organizations reported an increase in the use of open source software, with 36% indicating a significant increase. The reasons for that increased adoption are familiar as well – most respondents indicated that they use open source software to access the latest innovations.

But there are some new stories, too. The continued expansion of the digital economy into all industries — when paired with the "great resignation" and the ongoing pandemic — has turned finding qualified open source talent into a major hurdle for organizations of all shapes and sizes.

Even with that turmoil, the future for open source software is undoubtedly bright. Organizations, at a minimum, are becoming more open source aware – and many are contributing back to open source projects and organizations to ensure that the open source they ingest is stable, secure, and community-driven. Open source is finding new footholds in emerging areas, and becoming more accessible and more critical to all manner of organizations.

On behalf of OpenLogic by Perforce and the Open Source Initiative, I invite you to read and enjoy this report, to continue to enrich your open source knowledge, and to contribute back to the open source software communities that make reports like these possible.

Happy reading,

Javier Perez
Chief Evangelist, Open Source and API Management
OpenLogic by Perforce

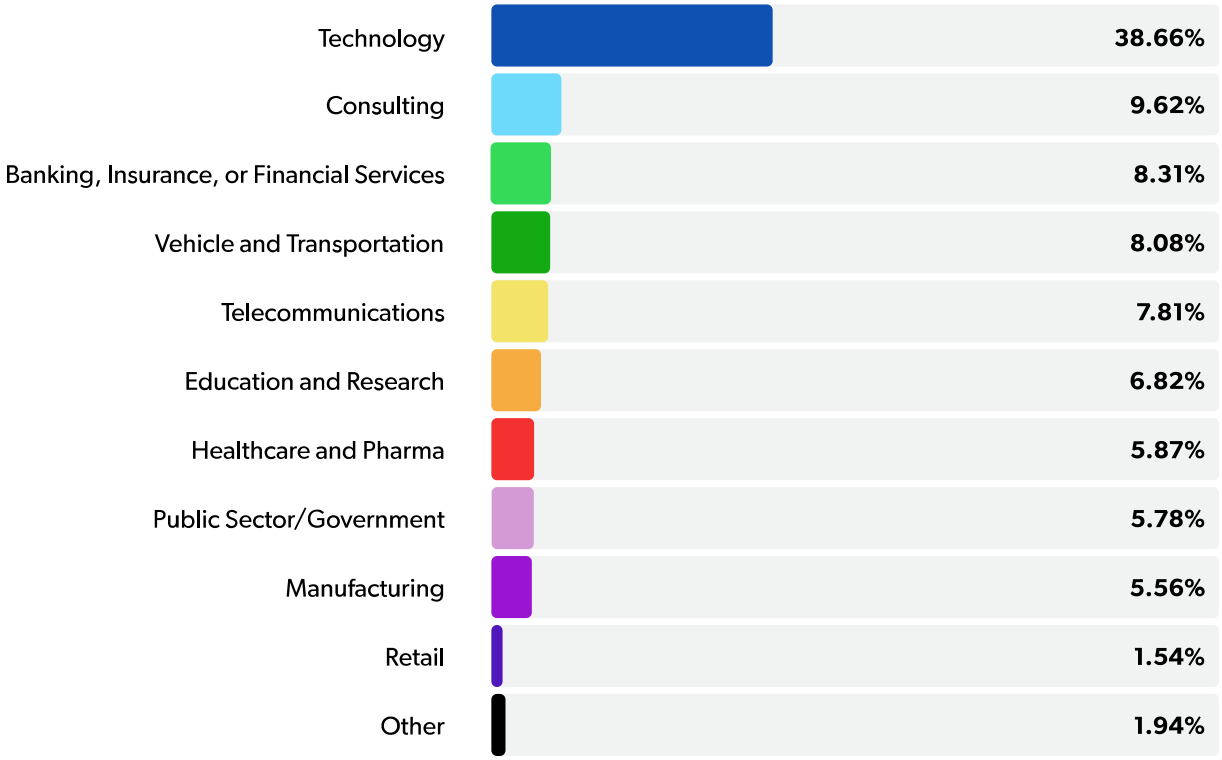
Table of Contents

About the Survey

The 2022 State of Open Source Report is based on an anonymous survey conducted between November 30, 2021, and January 6, 2022. It targeted professionals around the world working with open source software in their organizations. The survey received a total of 2,660 responses. To help segment and analyze the survey results, we asked respondents basic firmographic questions, including their company vertical, size, region, and job title.

VERTICAL

It was no surprise that the largest block of respondents work in the technology space. Respondents from a variety of industries also participated, from Consulting and the Financial sector, to other verticals like Healthcare and Manufacturing. Only a small percentage of respondents selected "Other" industry, among them the Gaming and Media industries.

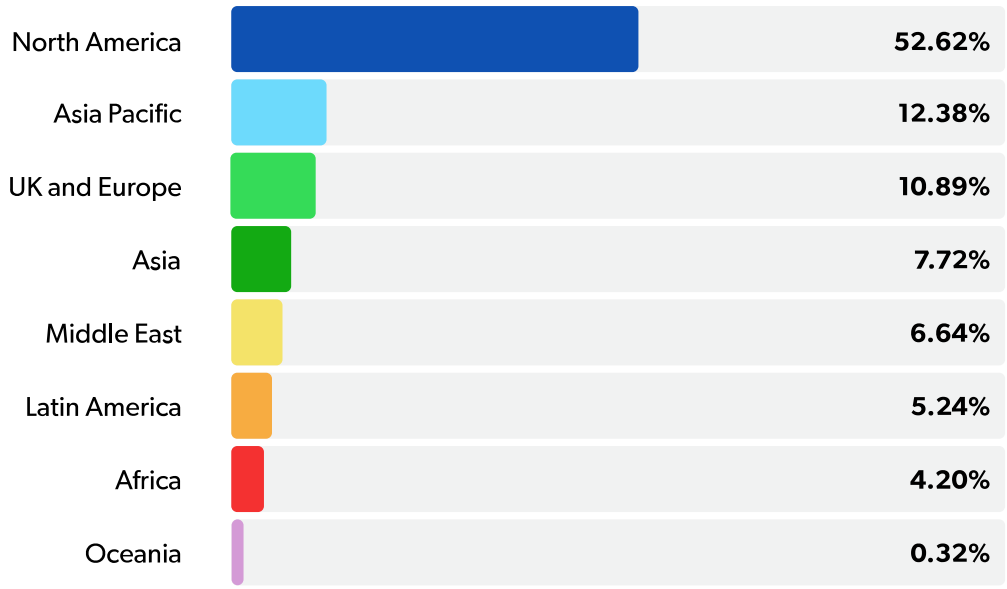


COMPANY SIZE

Our survey respondents represented a nearly-even distribution of large, medium, and small organizations. Everyone is using open source software.

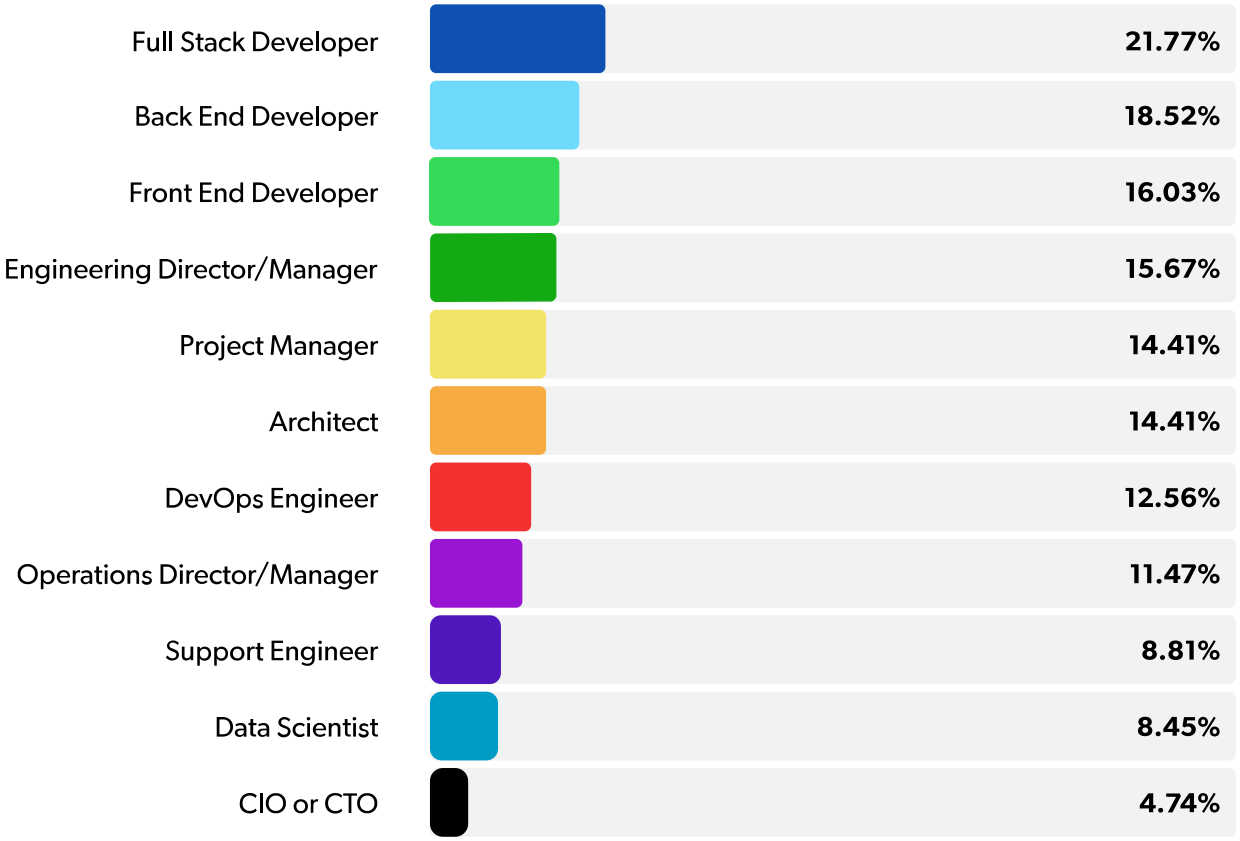
REGION

Open source software is global, and while the survey initially targeted a North American audience, it quickly drew responses from across the world — even a few from Oceania.



JOB TITLE

To finalize demographic information and to help the readers of this report understand who participated in the survey, we asked the respondents to select the closest option to their current job title. There is a large set of current roles involved with open source software among respondents. We also received responses from CEOs, professors, and consultants.



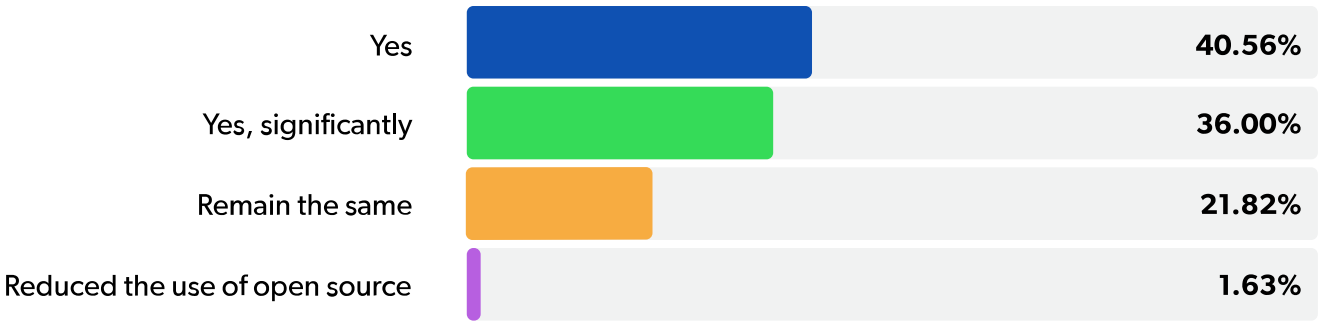
Survey Results

USE OF OPEN SOURCE SOFTWARE

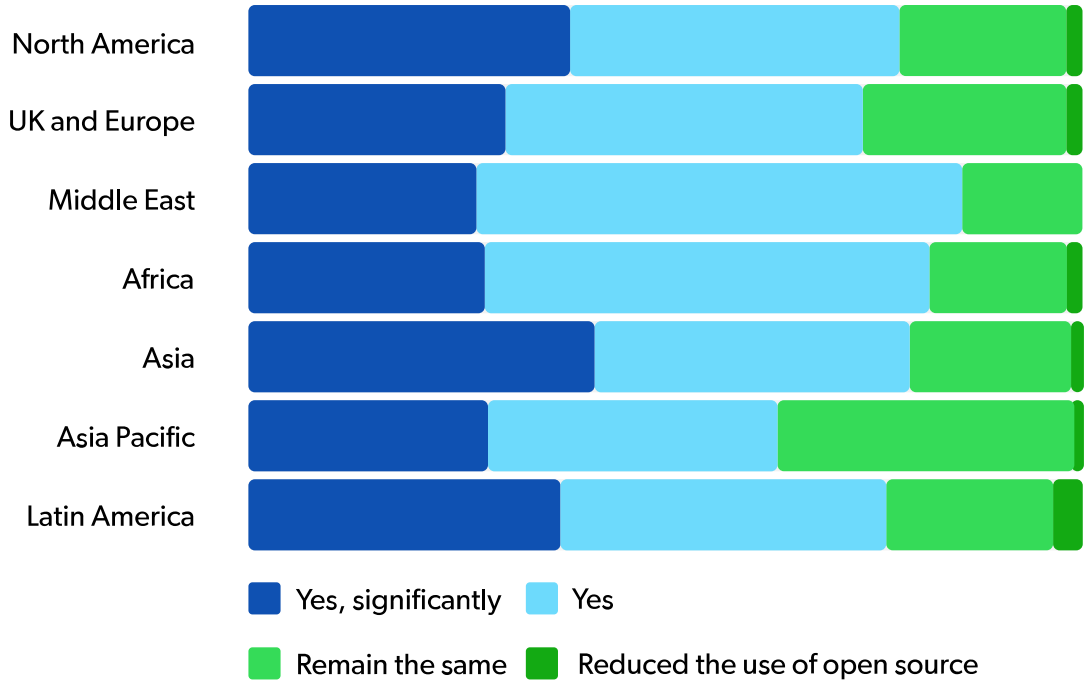
After the demographic questions, we started the State of Open Source Software survey with a question about organizational usage and adoption of open source software within the past year. We received an emphatic YES, with over 77% of respondents indicating they have increased the use of open source software in their organizations, and an impressive 36% indicating that they significantly increased the use of open source. Perhaps even more interesting is that only 1.6% of over two thousand respondents indicated that they reduced the usage of open source software. By this, and other measurements, we can safely say that the use of open source software is greater than ever and continues to grow.

> "77% of respondents indicated they have increased the use of open source software in their organizations"

Q **Has Your Organization Increased the Use of Open Source Software Over the Last Year?**



When looking at responses by region, there are even more impressive numbers. Four regions - North America, Middle East, Africa, and Asia - increased the use of open source in their organizations by over 80%.



COMMONLY-USED OPEN SOURCE TECHNOLOGIES

After our demographic and firmographic questions, we asked about the type of open source software used in their organizations. Across all respondents, we can see that the adoption is no longer dominated by one or two types of technologies such as programming languages and Linux operating system. We see that organizations are using open source software across a vast spectrum of technologies.

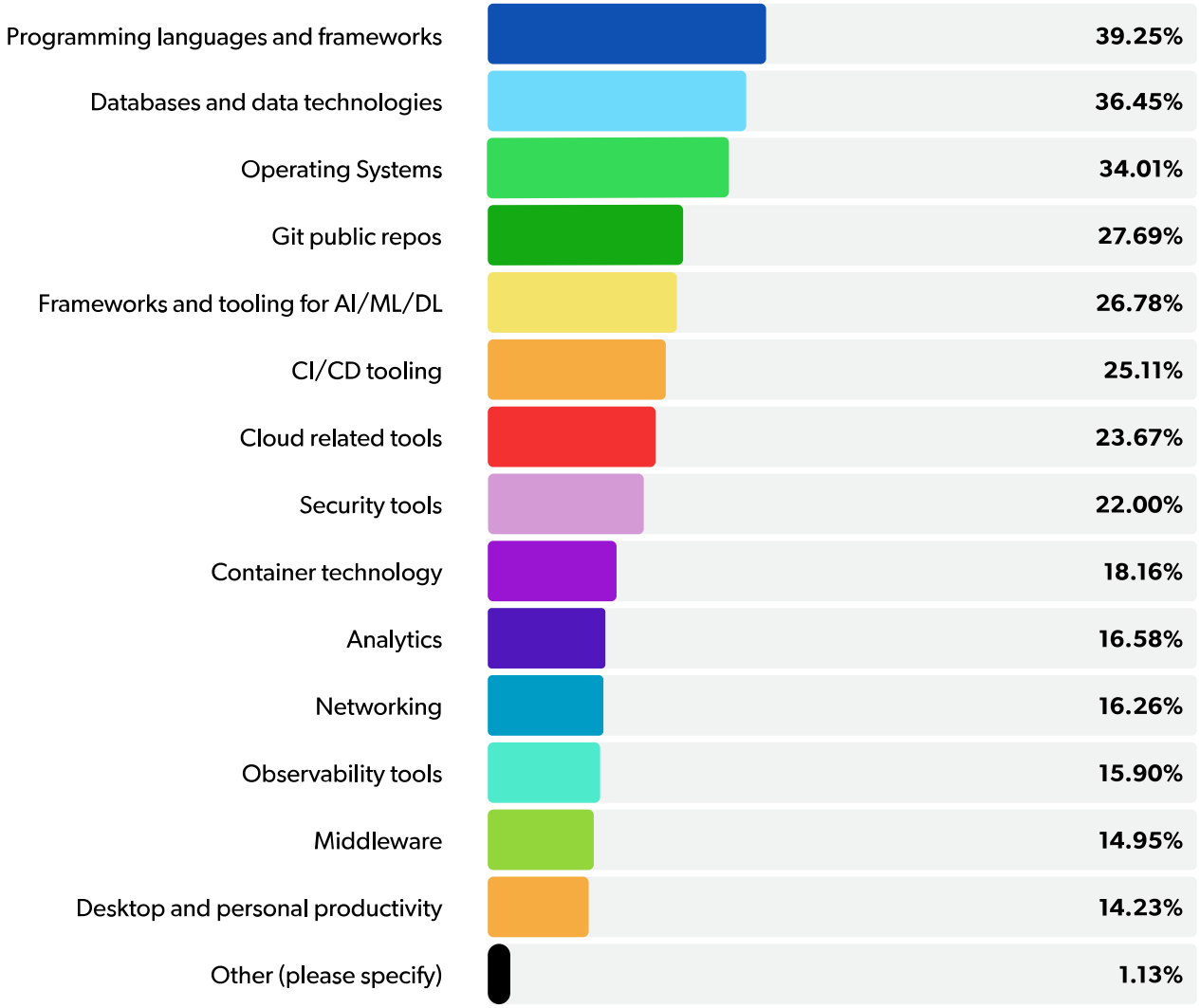
> "Open source adoption is no longer dominated by programming languages and Linux. Open source usage now spans a vast spectrum of critical technologies."

We can highlight that, as expected, the growth and diversity of open source data technologies is the result of high demand for innovation and alternatives to proprietary software. This growth is evident in the results, with 36.4% of respondents using open source data technologies in their organization. Open source CI/CD tooling continues to gain adoption, with our results indicating there's more usage of open source CI/CD tooling than the use of container technology or open source middleware.

As we break down the usage results of open source CI/CD tooling, we can see a clear distinction between small and large organizations. Over 35% of the respondents working in large organizations (over 1,000 employees) are using open source CI/CD while there is only 19% adoption in small organizations (under 100 employees). Perhaps the reduced number of developers in small organizations allows them to manage releases without CI/CD, while it has become a must-have for large organizations.

The 22% use of open source security tools is an important number that we hope to see increasing over the next 12 months.

What Type of Open Source Software Is Used in Your Organization?



Top Concerns in Using Open Source Software

The adoption and usage of open source software started many years ago. Last year's 30th anniversary of Linux reminded us that open source software started to take off three decades ago. Despite amazing growth by all measurements, and more so with the use of the cloud and cloud-native technologies in recent years, there are still reservations for consuming some open source technologies. We asked for the most common concerns or reservations in the use of open source software, and we obtained five top answers across our large number of respondents:

- Lack of internal skills to test, use, integrate, and support
- Restrictions in some open source licenses
- It doesn't scale as well as proprietary software
- There's no real-time support
- I don't have any reservations

These top five reservations largely didn't diverge for large, medium, or small organizations, although the "I don't have any reservations" jumped to the top response for small organizations. Over 27% of the respondents indicated that they don't have any reservations using open source software, vs. 37% in small organizations.

> "37% of small organizations expressed no reservations in using open source software."

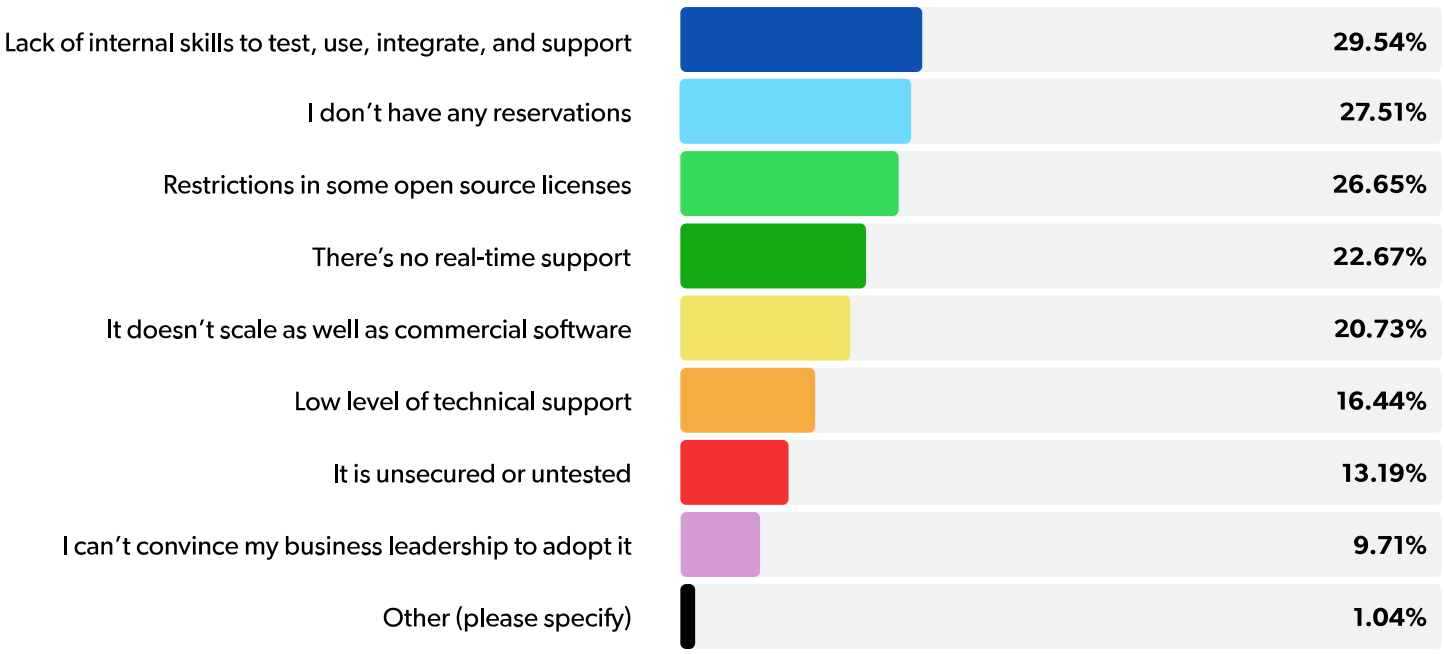
Lack of internal skills and formal technical support continues to be a top concern in the use of open source software. Respondents in industries such as Finance and Telecommunications clearly showed those reasons as top concerns in adopting more open source software.

Restrictions in some open source licenses are an important highlight for this report. The Open Source Initiative (OSI), co-sponsor of this report, has worked for years on promoting awareness and education of open source software licensing. This survey result shows us there is significant awareness of open source licenses. This points to an understanding of the impact on proprietary software, depending on what open source license is used, from copyleft options to patent provisions.

> "There is significant awareness of open source licenses — marking a solid understanding of open source licenses with copyleft restrictions."

Breaking down the survey results by the roles of the respondents, restrictions in some open source licenses was a top reservation among Engineers and Developers. All said, it is great to see progress in awareness of open source licenses.

Q **What Are Your Reservations (Select all That Apply) in Using Open Source Software?**



Top Factors for Using Open Source Software

After asking about reservations on the use of open source software, the next logical step was to identify the top reasons why organizations choose open source software. We asked for the most common reasons for the use of open source software, and again, we obtained a clear "top-five" selection across all respondents.

- Access to innovations and latest technologies
- No license cost, overall cost reduction
- To modernize technology stack
- Many options for similar technologies
- Constant releases and patches

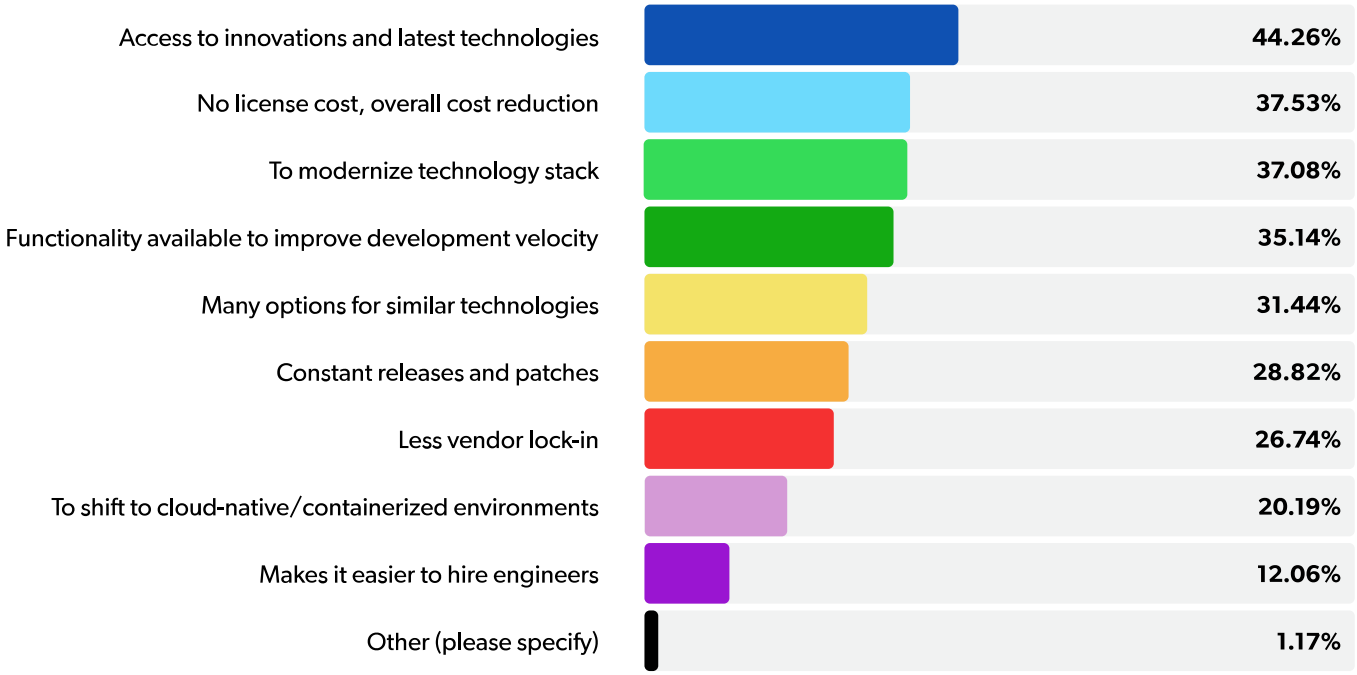
In order of selection, we highlight that access to innovation was the top selection, followed by no license cost and overall cost reduction. This result reinforces the fact that people are choosing open source software because that's where software innovation is happening. The reusability of open source software, including thousands of libraries, allows organizations to reduce costs, and speed up time to market — all while modernizing their technology stack. In fact, over 36% of respondents indicated they use open source to modernize their technology stack. It's no surprise that the use of container technology, cloud-related tools, and data technologies are the types of open source software that organizations are using to modernize their stacks and keep up with new technologies.

> "People are choosing open source software because that's where software innovation is happening."

Over one third of respondents indicated that the number of options for similar technologies was a top factor in using open source software. From DevOps to data technologies, the maturation of open source communities fosters a growing ecosystem of technologies.

Using open source software to reduce vendor lock-in received 27% of responses. Meanwhile, a surprisingly low number of respondents (12%) indicated that open source makes it easier to hire engineers.

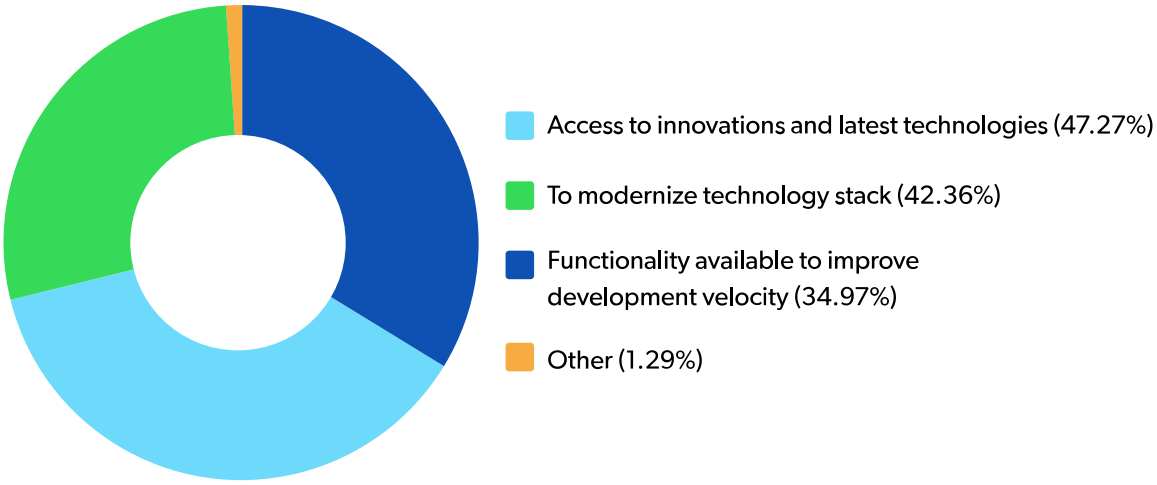
Q **What Are the Top Reasons for Your Organization to Use Open Source Software?**



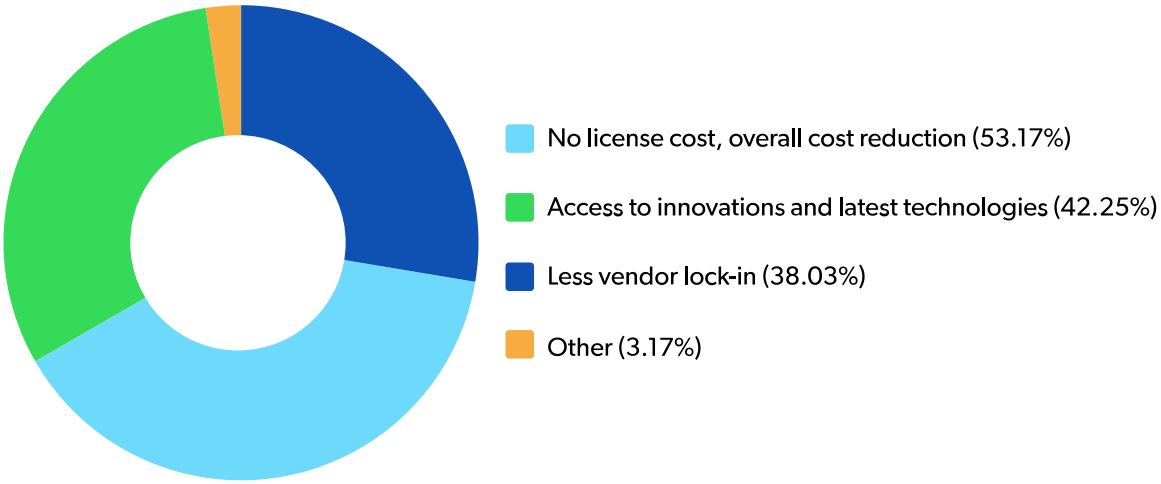
When we look at the top factors to use open source software by geographical region, we made an interesting discovery — the top three factors vary widely across our top three respondent regions.

In the case of North America and the UK and Europe you can see in the charts below that the reasons to use open source software varies. We should highlight that in the UK and Europe the number one reason to use open source software in organizations is no license cost and overall cost reduction. While in North America, access to innovation and latest technologies is the biggest factor.

North America



UK and Europe



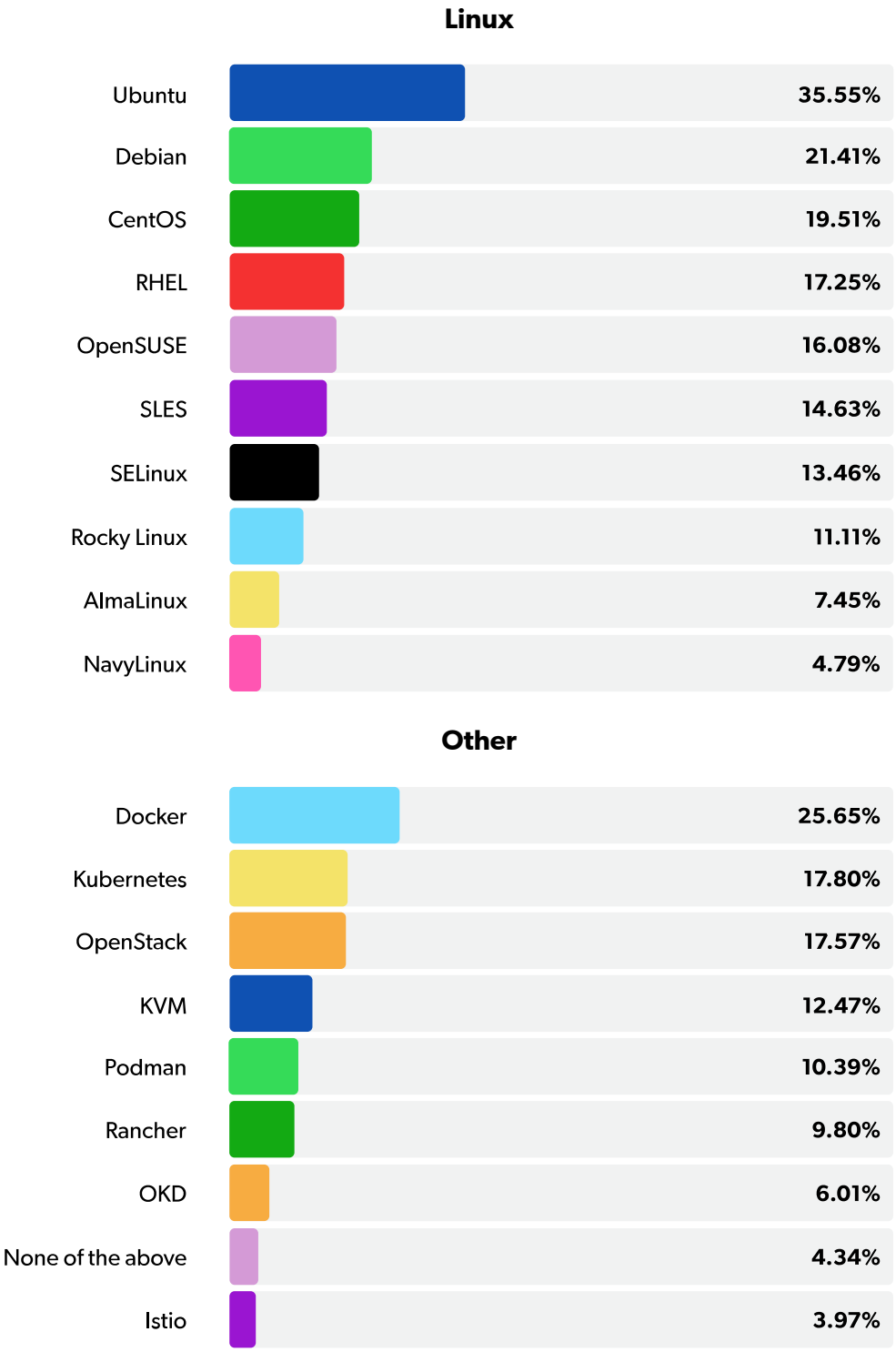
Top Open Source Infrastructure Technologies

In this section of the report, we focus on the most-used open source infrastructure technologies and considerations for their use. To determine the most-used technologies, we created a list of the most popular options, including a combination of open source Linux distributions, virtualization technologies, and container-related technologies. There was no limit in the selection, allowing respondents to select all open source infrastructure technologies used in their organizations.

As in previous years, Ubuntu Linux and Docker were the most popular technologies used in open source infrastructure. In many cases, respondents selected multiple Linux distributions — indicating that respondent organizations have diverse development and production environments.

Container technologies following the Open Container Initiative standards (e.g. Podman, Docker, and others) showed significant usage. But, just like Kubernetes and related container orchestration technologies, they still have plenty of room for growth.

Q **Which of These Open Source Technologies Does Your Organization Use Today to Support Your Software Infrastructure?**



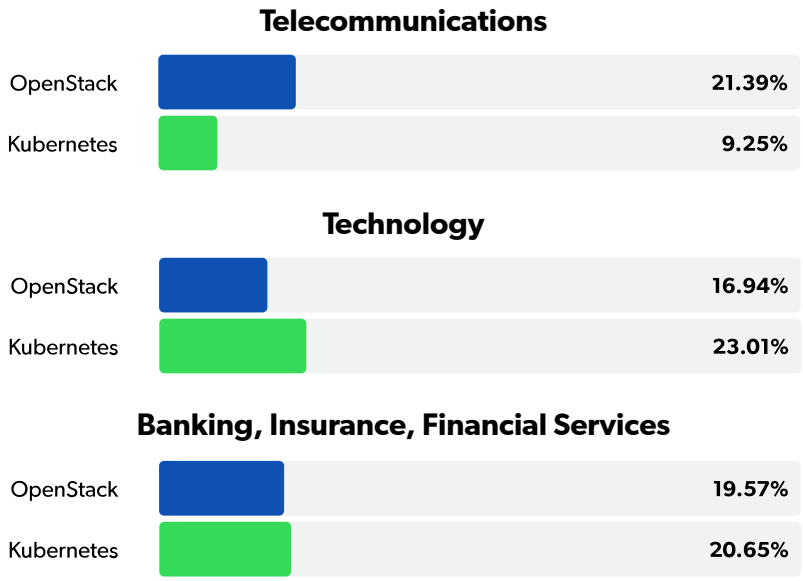
As expected, given the recent CentOS 8 end-of-life (December 31, 2021), we saw a reduction in the use of CentOS compared to last year's survey. The top three Linux distributions continue to be Ubuntu, Debian, and CentOS.

> "Rocky Linux, AlmaLinux, and Navy Linux showed significant gains."

New Linux distributions that come from copies or forks of CentOS, like Rocky Linux, AlmaLinux, and Navy Linux, showed significant gains — especially given the fact that they did not exist 12 months ago.

Another highlight is the fact that OpenStack usage beat Kubernetes by 2%, with 17% vs. 15% overall usage. When we break down those two results by industry, we see larger differences in the Technology and Telecommunications industries.

> "OpenStack is a popular selection in the telecommunications industry as well as banking, insurance and financial services."



WHY TEAMS CHOOSE OPEN SOURCE INFRASTRUCTURE TECHNOLOGIES

After respondents listed the open source infrastructure technologies used in their organizations, we asked what they considered important when choosing those technologies. In order of importance, respondents selected the top five reasons to use their selected open source infrastructure.

The survey found that, just like in the previous year's survey, security and patches were the most important point of consideration when choosing infrastructure technologies like Linux distributions and containers. 27% of respondents reported it as their most important consideration, followed closely by stability and robustness of the technology at 26%.

Level of proficiency and experience was also a top factor, and was clearly shown as the third most important factor for most respondents.

Licensing cost, while an important factor, obtained the fewest "most important" classifications among respondents. This again highlights that open source infrastructure software is widely used for its benefits in security, patching, and stability — and that licensing costs are considered a less important factor.

Q **In Order of Importance (Not Important — Most Important) Rank the Reasons You Chose This Technology Mix for Your Software Infrastructure?**

	Not Important	Mildly Important	Important	Very Important	Most Important
Licensing cost	4.77%	17.90%	31.58%	29.26%	16.49%
Enterprise technical support	4.61%	17.02%	31.93%	30.16%	16.29%
Security and patches	1.32%	11.56%	27.50%	32.57%	27.04%
Stability and robustness	1.59%	11.44%	26.07%	34.15%	26.75%
Level of proficiency and experience	2.14%	13.97%	29.75%	32.89%	21.25%

When we look at the same considerations for using open source infrastructure among respondents working for large organizations (over 1,000 employees), having security and patches remains the most important reason. An interesting fact is that the key factor related to having enterprise technical support was classified as only important, not very important or most important. This last statistic highlights the fact that large organizations are using community versions of open source without paying for proprietary versions of important infrastructure technologies like Linux and container tooling.

> "Large organizations use community versions of important open source infrastructure technologies without paying for proprietary versions - like Linux and container tooling."

	Most important reasons to select open source infrastructure technology among large organizations:
1.	Security and patches 27%
2.	Stability and robustness 26%
3.	Level of proficiency and experience 20%

By breaking down the reasons to use open source infrastructure by industry, we were able to better understand the requirements and perceptions of each industry.

The following chart shows each factor, followed by the industry that selected it most commonly as their top factor in using open source infrastructure software.

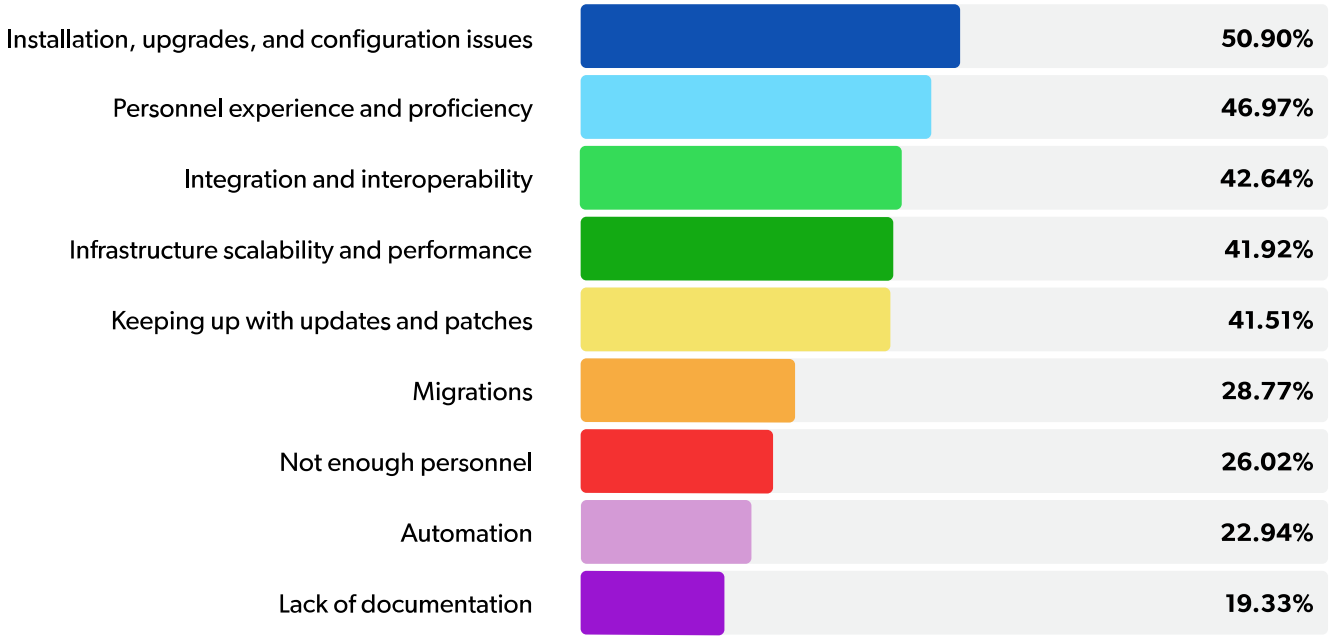
- Licensing cost: Banking, Insurance, or Financial Services
- Enterprise technical support: Manufacturing
- Security and patches: Technology
- Stability and robustness: Technology
- Level of proficiency and experience: Vehicle and Transportation

CHALLENGES WITH OPEN SOURCE INFRASTRUCTURE TECHNOLOGIES

After ranking the top five reasons why respondents use their selected open source infrastructure, we asked about the support challenges while using that selected open source infrastructure. Speaking to the level of maturity and frequent use of these technologies, the responses highlighted the need for improvements, more open source software, more open source contributions, and business opportunities to address those challenges.

51% of respondents listed installation, upgrades, and configuration issues as the top challenge in using their open source infrastructure technologies. This top challenge is closely related to the number two reason selected, personnel experience and proficiency – which represented 47% of respondents. These findings point to the complexity of administration, support, and maintenance of infrastructure technology and, in many cases, the necessity of expert level and certified personnel.

Q **What Are the Main Support Challenges on Your Open Source Software Infrastructure?**



When we look at the same support challenges when using open source infrastructure among respondents working for large (over 1,000 employees) and medium organizations (100-1,000 employees), the results are very similar. For respondents working in small organizations (less than 100 employees), infrastructure scalability and performance was not a support challenge.

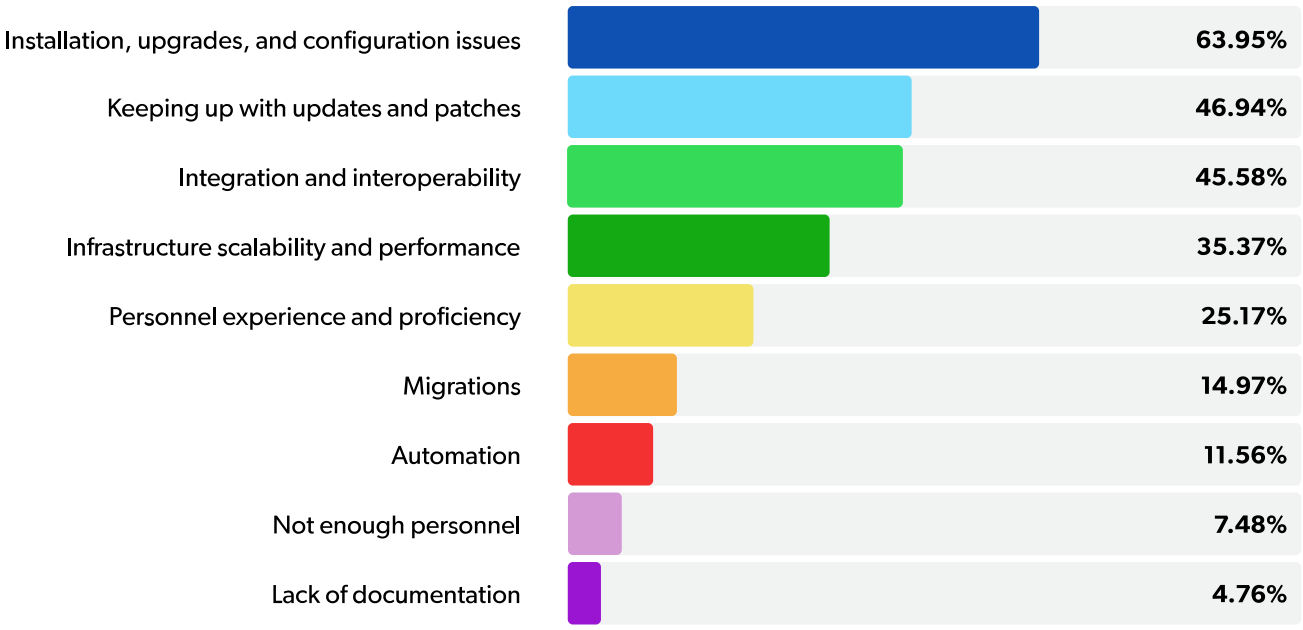
	Most important support challenges for open source infrastructure technology among small organizations:
1.	Installation, upgrades, and configuration issues: 49%
2.	Personnel experience and proficiency: 43%
3.	Keeping up with updates and patches: 41%

Of course, the top support challenge varies by industry. The chart below shows which industry most closely aligned with each challenge:

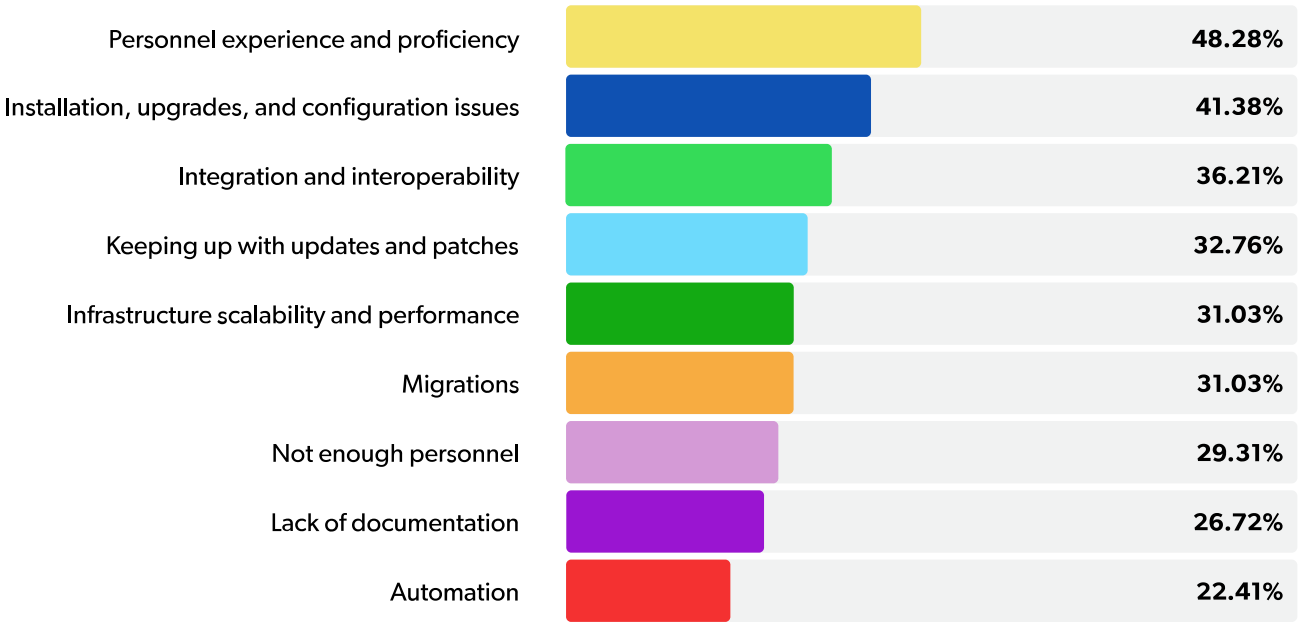
- Not enough personnel: Education and Research 35%
- Personnel experience and proficiency: Education and Research 55%
- Installation upgrades and configuration issues: Banking, Insurance, or Financial Services 55%
- Infrastructure scalability and performance: Banking, Insurance, or Financial Services 48%
- Integration and interoperability: Retail 53%
- Keeping up with updates and patches: Telecommunications 50%
- Migrations: Public Sector/Government 38%
- Automation: Banking, Insurance, or Financial Services 34%
- Lack of documentation: Manufacturing and Telecommunications 24%

Support challenges also vary by region. In particular, two regions showed significant differences on the top support challenges when using open source infrastructure.

Middle East



Latin America



Top Open Source Programming Languages/Runtimes

As in previous years, we dedicated a section in this survey to understand the use of open source programming languages. This year, to keep up with current trends, we increased the list of popular open source programming languages and runtimes to a list of 14 options, including OpenJDK, PHP, Python, JavaScript, Node.js, and more.

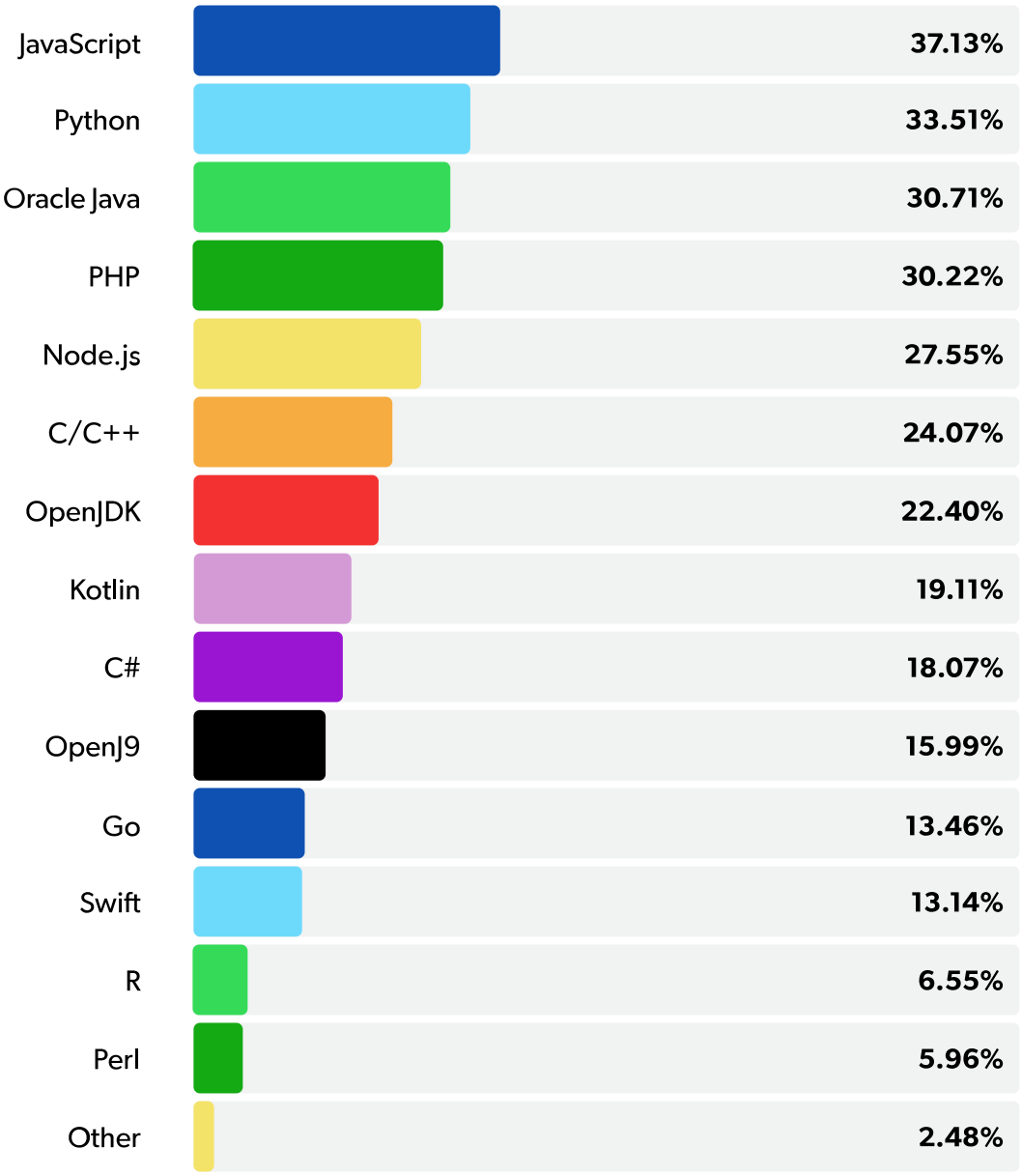
In looking at the results, we can see the continued growth of Python adoption — which is largely due to the increased prevalence of AI-related applications. Our survey found JavaScript as the most-used programming language, and Java still heavily used by many organizations.

> "We can see the continued growth of Python adoption — which is largely due to the increased prevalence of AI-related applications."

For this year's survey we included the three most popular open source Java runtimes: OpenJDK, OpenJ9 and Oracle Java. With the much larger number of respondents in this year's survey, Oracle Java went back to the most used, followed by OpenJDK, and then OpenJ9.

The survey results showed significant use of all programming languages and runtimes, we also allowed respondents to include additional open source languages, with only Ruby passing 1% usage.

Q **Which Technologies (Select all That Apply) Does Your Organization Use to Build Applications Today?**



We can highlight that the use of Java runtimes shows differences depending on the size of the organization. However, large organizations (over 1,000 employees) are almost equally using OpenJDK and Oracle Java (49% vs. 51%).

	OpenJDK	OpenJ9	Oracle Java
Large (more than 1,000 employees)	48.72%	26.53%	51.02%
Medium (100 to 1,000 employees)	29.36%	35.73%	54.62%
Small (under 100 employees)	44.75%	20.99%	59.12%

WHY TEAMS CHOOSE OPEN SOURCE PROGRAMMING LANGUAGES/RUNTIMES

After respondents listed the programming languages and runtimes used in their organizations, we asked what they considered important when choosing those languages. In order of importance, respondents chose the top five reasons they use their open source programming languages and runtimes.

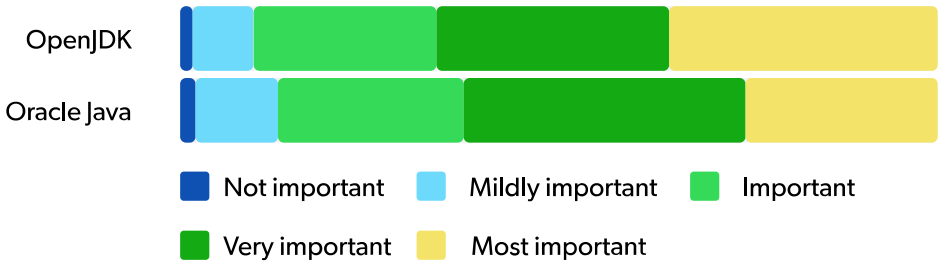
Unlike last year's survey where features and functionality was the top consideration, this year respondents listed stability and robustness as their most important consideration at 28%. A further 26% reported availability of security and patches and their most important consideration, and 26% reported level of proficiency and experience as their top choice.

In Order of Importance (Not Important — Most Important) Rank the Reasons You Chose These Languages for Your Development?

	Not Important	Mildly Important	Important	Very Important	Most Important
Features and functionality	3.03%	13.89%	26.56%	33.44%	23.08%
Enterprise technical support	5.45%	17.34%	30.50%	30.14%	16.57%
Security and patches	1.55%	13.69%	26.96%	31.84%	25.96%
Stability and robustness	1.09%	9.97%	27.31%	33.45%	28.17%
Level of proficiency and experience	1.68%	12.46%	27.88%	32.29%	25.69%

Going back to the comparison between OpenJDK and Oracle Java, we found that users of OpenJDK indicate that the availability of security patches is the most important reason to select OpenJDK. This marks a 10% difference with the selection of most important factor for Oracle Java.

> "Oracle Java users listed availability of security patches as 10% less important when compared to OpenJDK users."



Breaking down the reasons to use the open source programming languages/runtimes by industry resulted in interesting insights about the differing requirements and perceptions by industry.

The following chart shows the industries with the highest percentage selected as the most important factor to use a programming language.

- Features and functionality: Manufacturing
- Enterprise technical support: Banking, Insurance, or Financial Services
- Security and patches: Manufacturing and Technology
- Stability and robustness: Technology

CHALLENGES WITH OPEN SOURCE RUNTIMES

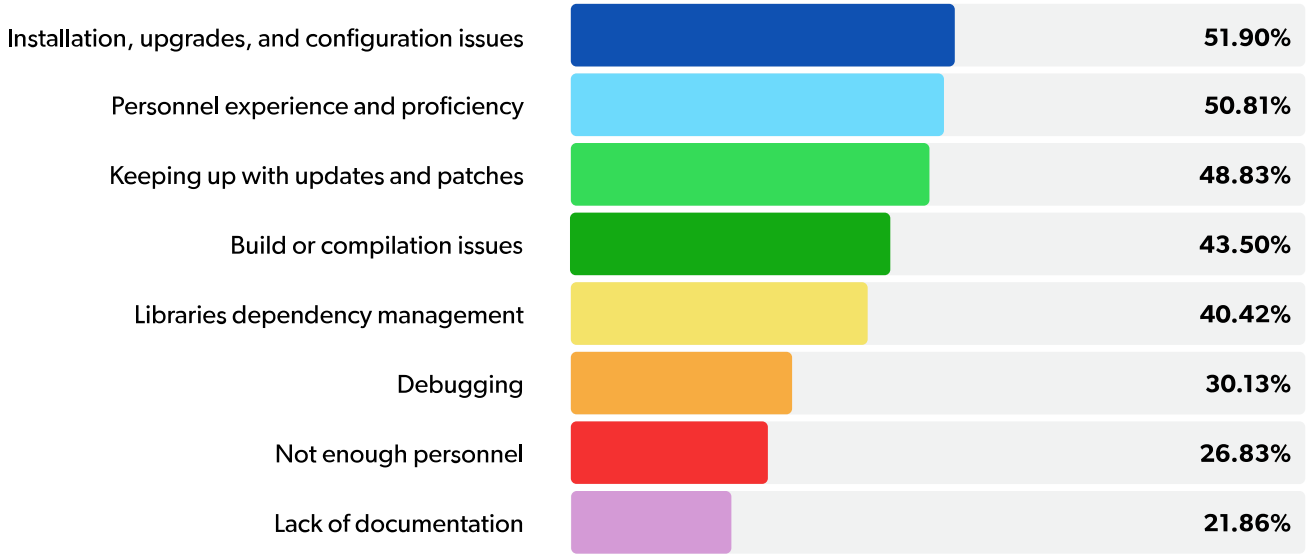
After ranking the top reasons to use selected open source programming languages and runtimes, we asked about the support challenges while using selected languages and runtimes.

Since most programming languages are open source, and they have been used for many years (in some cases, decades), we wanted to see if the support challenges differ from other types of open source. The results were similar, with top challenges clearly identified.

The top support challenge in using open source programming languages and runtimes was installations, upgrades, and configuration issues, which was selected by 52% of the respondents. It was not surprising to see personnel experience and proficiency as a close second with 51% of respondents.

Build and compilation errors and dealing with libraries dependency management were also among the top challenges.

Q **What Are the Main Support Challenges on the Open Source Programming Languages You Use to Build Applications?**



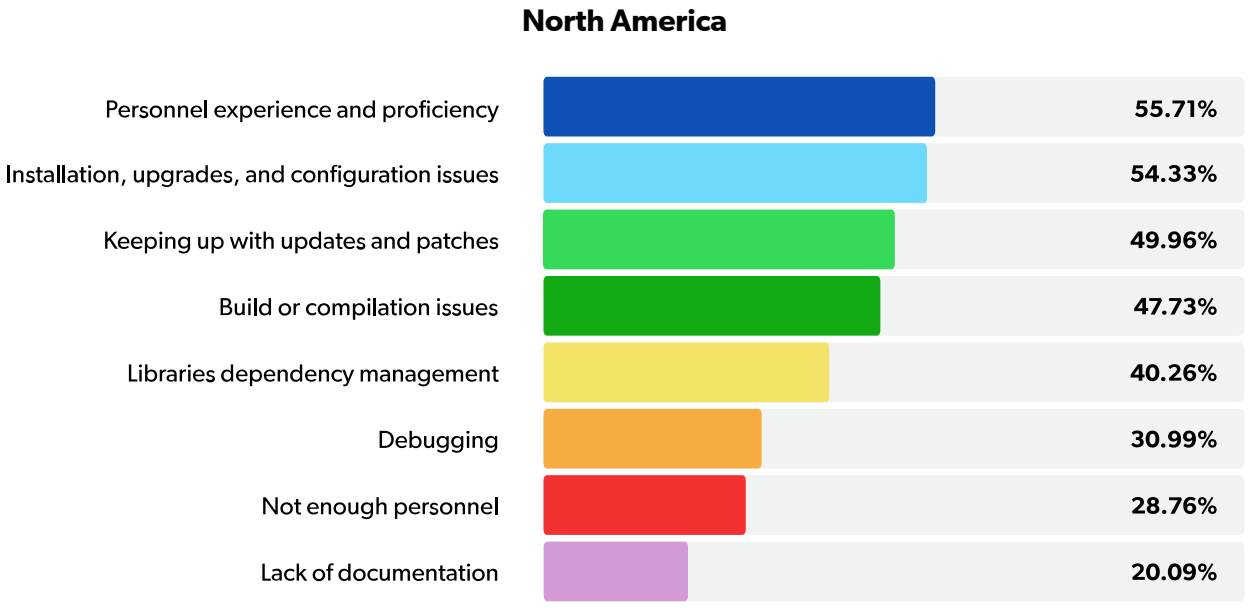
When we look at the same support challenges among respondents working for large organizations (over 1,000 employees) the results changed in the top three support challenges.

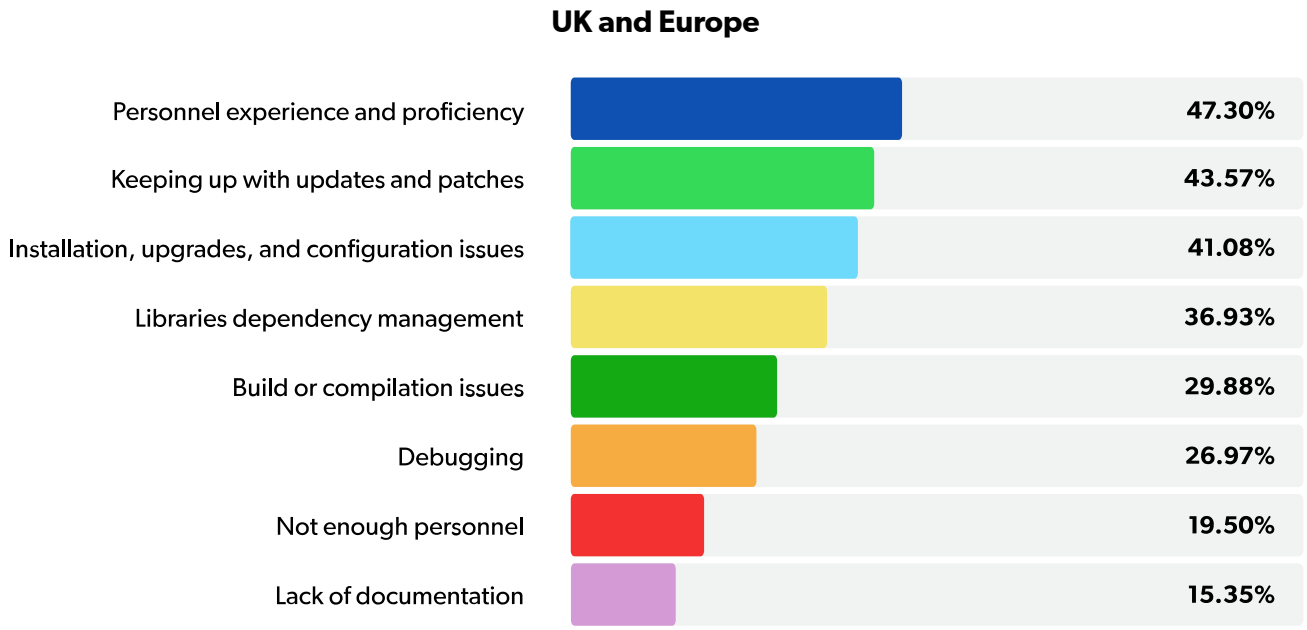
	Most important support challenges for open source programming languages/ runtimes among large organizations:
1.	Keeping up with updates and patches: 53%
2.	Personnel experience and proficiency: 51%
3.	Installation, upgrades, and configuration issues: 50%

The support challenges for open source programming languages and runtimes also varied by industry. The following chart shows the industry with the highest percentage selected for each one of the support challenges:

- Not enough personnel: Education and Research 35%
- Personnel experience and proficiency: Education and Research 55%
- Installation upgrades and configuration issues: Banking, Insurance, or Financial Services 55%
- Keeping up with updates and patches: Manufacturing 55%
- Build or compilation issues: Telecommunications and Healthcare/Pharma 51%
- Libraries dependency management: Banking, Insurance, or Financial Services 46%
- Debugging: Healthcare and Pharma 38%
- Lack of documentation: Manufacturing and Healthcare/Pharma 29%

Support challenges also varied by region. Specifically, two regions showed clear differences in the selection of support when challenges using open source programming languages and runtimes.





Top Open Source Framework Technologies

For this year's State of Open Source survey, we included a new category for open source frameworks. While open source frameworks are specific to their corresponding programming language, they have become a key open source component for software developers due in part to the rapid expansion of viable options. We have seen significant growth of the various open source framework communities, with some already possessing large communities with contributors from around the world.

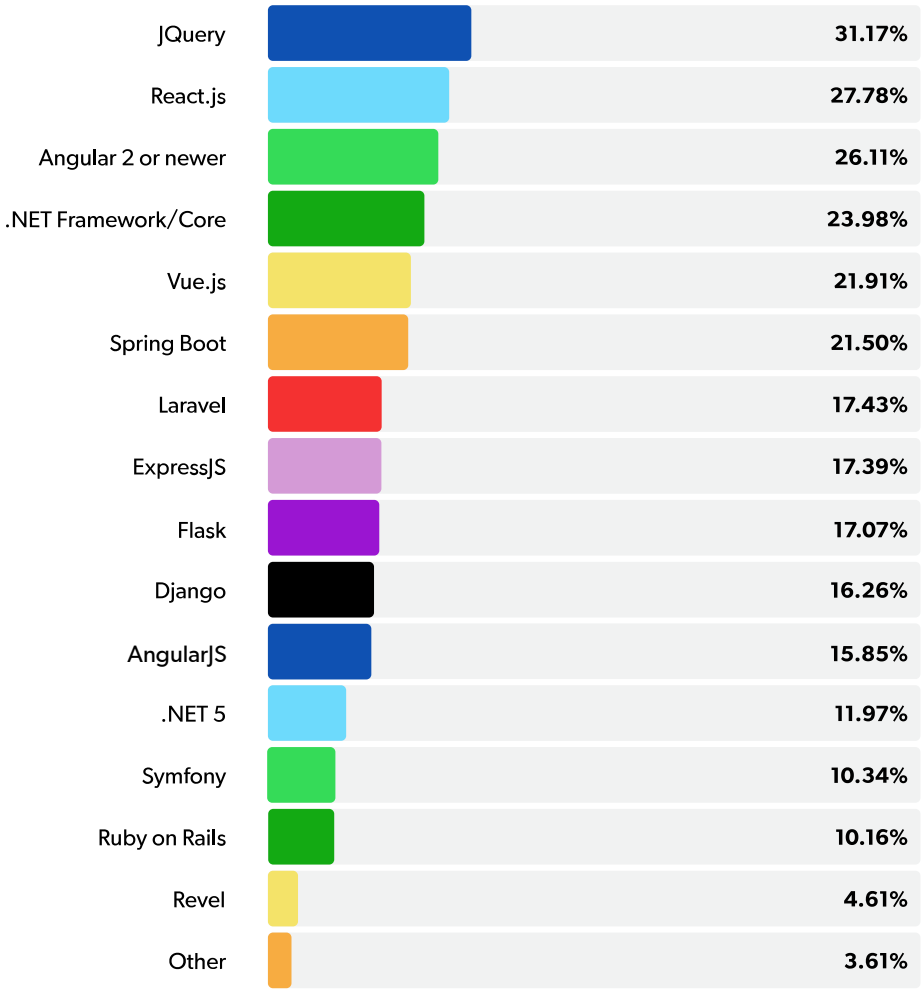
For our first question, respondents had the option to select all open source frameworks they are using in their organizations. The results show that the typical organization is using more than one or two frameworks. While it could be only for experimentation or learning, it's a fact that coding with open source frameworks is an integral part of nearly all software development and there are many options to choose from.

Since our survey found JavaScript as the most used programming language, it is logical to see JavaScript frameworks leading in usage among our large set of respondents. JQuery, React, and Angular were indicated as the top three most-used open source frameworks. Given that AngularJS has recently reached end of life, it's surprising to see so many organizations still using it.

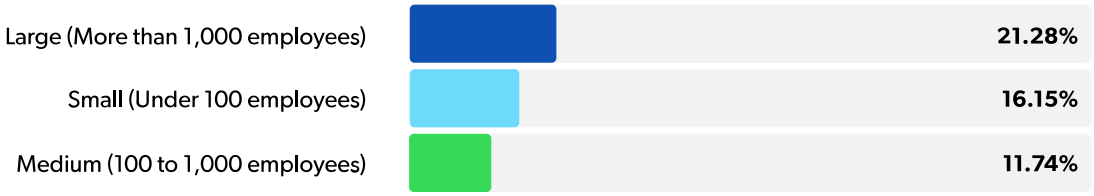
Looking at other popular programming languages, we see high use of high use of .NET Framework/Core for .NET development, and Spring Boot for Java development.

"15% of respondents are still using end-of-life AngularJS. 21% of large organizations are still using end-of-life AngularJS."

Q **Which Technologies (Select all That Apply) Does Your Organization Use to Build Applications Today?**



We can highlight that the use of AngularJS (version 1) varies significantly by the size of the organization. In fact, our survey found that 21% of large organizations (over 1,000 employees) are still using AngularJS, vs. 12% and 16% in medium and small organizations, respectively.



Another interesting finding is the widespread use of the .NET, .NET 5, and Spring Boot frameworks across organizations of all sizes. The results show just as much use of .NET, .NET 5, and Spring Boot frameworks among medium and small organizations.

	Large	Medium	Small
.NET framework	26.40%	15.04%	25.92%
.NET 5	19.84%	7.98%	20.30%
Spring Boot	26.97%	14.19%	19.10%

For JavaScript frameworks, we found differences in the preference of Angular vs. React by industry, with some industries preferring Angular, and some preferring React.

	Angular 2 or Newer	React.JS
Technology	29.91%	36.80%
Consulting	17.37%	23.94%
Telecommunications	24.86%	20.81%
Banking, Insurance, or Financial Services	25.54%	29.35%
Education and Research	26.49%	23.84%
Vehicle and Transportation	26.82%	20.67%
Public Sector/Government	21.88%	17.19%
Healthcare and Pharma	32.31%	21.54%
Manufacturing	21.95%	13.82%
Retail	11.76%	14.71%

WHY TEAMS CHOOSE OPEN SOURCE FRAMEWORK TECHNOLOGIES

After respondents listed the open source frameworks used in their organizations, we asked what they considered important when choosing those frameworks. In order of importance, respondents ranked the top five reasons why they use their selected open source frameworks.

The top selection was the stability and robustness of the open source framework, with 25% of respondents reporting it as their most important consideration. This reflects the expectation to use large and popular open source projects with large communities in order to enjoy a greater overall stability and robustness. An example of that stability and robustness is AngularJS, which was supported by the community for 11 years, with the first 6 years including regular improvements to the framework (until Angular 2.0 was released).

Similar to the selection of programming languages and runtimes, respondents selected level of proficiency and experience, as well as availability of security patches, as the most important factors in the selection of their frameworks.

In Order of Importance (Not Important — Most Important) Rank the Reasons You Chose These Frameworks for Your Development?

	Not Important	Mildly Important	Important	Very Important	Most Important
Features and functionality	6.94%	13.10%	27.06%	31.46%	21.44%
Enterprise technical support	6.36%	14.27%	29.00%	33.45%	16.91%
Security and patches	5.77%	9.90%	26.31%	33.62%	24.40%
Stability and robustness	5.59%	10.04%	27.70%	31.38%	25.30%
Level of proficiency and experience	6.04%	11.67%	27.66%	32.29%	22.34%

Breaking down the reasons to use the open source frameworks by industry, we noted different responses depending on the industry. The following chart shows the industries with the highest percentage selected as the most important factor to use open source frameworks.

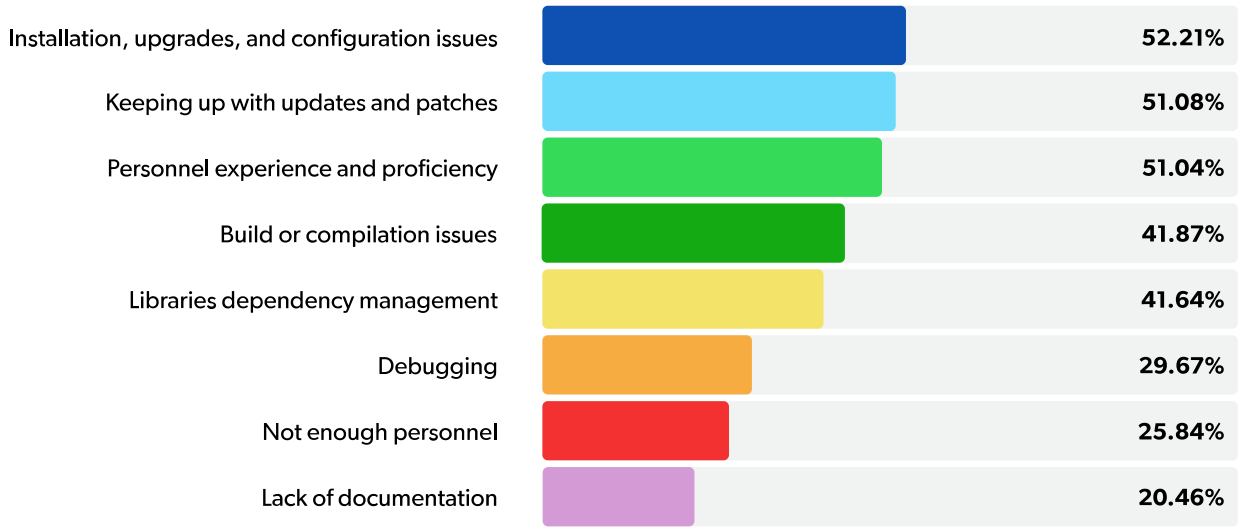
- Features and functionality: Public Sector/Government, Manufacturing and Healthcare/Pharma
- Available community support: Technology
- Security and patches: Manufacturing and Technology
- Stability and robustness: Manufacturing
- Level of proficiency and experience: Healthcare and Pharma

CHALLENGES WITH OPEN SOURCE FRAMEWORKS

After asking about why people choose their open source frameworks, we asked about the support challenges while using their selected frameworks.

Similar to open source programming languages and other open source technologies, the top support challenges in using open source frameworks were installations, upgrades, and configuration issues at 52%. It was not surprising to see personnel experience and proficiency, and keeping up with updates and patches tied for second at 51% of respondents.

Q **What Are the Main Support Challenges for the Open Source Frameworks You Are Using?**



When we look at the results for the same support challenges among respondents working for large organizations (over 1,000 employees), the order of the top three support challenges changed.

	Most important support challenges for open source programming frameworks among large organizations:
1.	Keeping up with updates and patches: 53%
2.	Installation, upgrades, and configuration issues: 51%
3.	Personnel experience and proficiency: 49%

For small organizations (under 100 employees) personnel experience and proficiency was their number one challenge at 51%, and for medium size organization (100 to 1,000 employees) installations, upgrades, and configuration issues was the top challenge with 55%.

The support challenges for open source frameworks by industry also showed some interesting differences. The following chart shows the industry with the highest percentage selected on each one of the support challenges:

- Not enough personnel: Manufacturing 29%
- Personnel experience and proficiency: Technology 56%
- Installation upgrades and configuration issues: Manufacturing 60%
- Keeping up with updates and patches: Healthcare and Pharma 58%
- Build or compilation issues: Banking, Insurance, or Financial Services 54%
- Libraries dependency management: Education and Research 50%
- Debugging: Manufacturing 43%
- Lack of documentation: Healthcare and Pharma 30%

Top Open Source Data Technologies

On the important topic of managing data, we have seen a proliferation of open source data technologies. It's no longer only about databases or database types — data technologies cover streaming data, functionality for efficient creation of analytics, a variety of integration capabilities, and more. With this in mind, we selected the most popular open source data technologies in this survey. Without limiting the number of selected options, we allowed respondents to select all the open source data technologies — in some cases more than four — used in their organization.

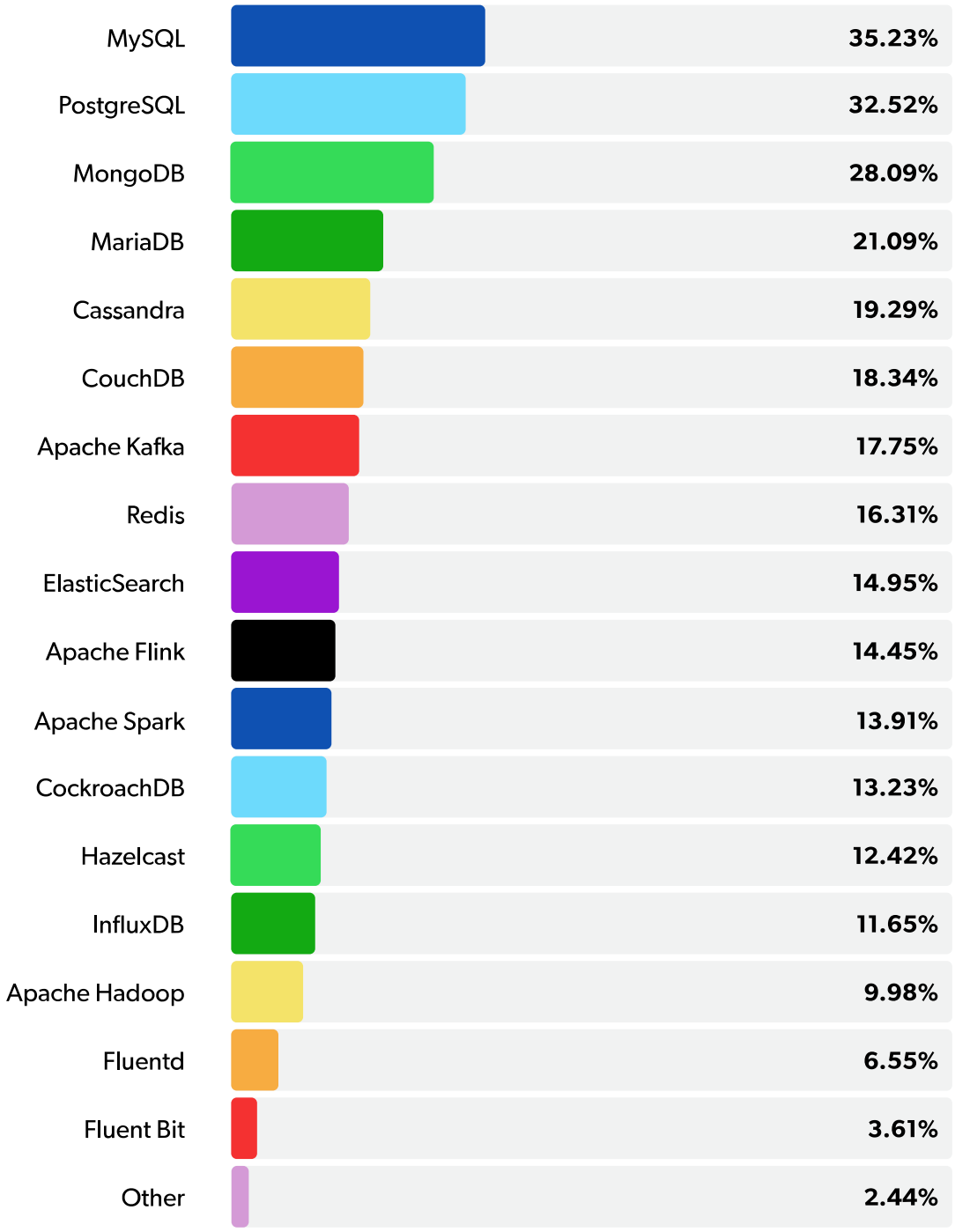
As in last year's report, the top three most used data technologies were MySQL, PostgreSQL, and MongoDB. We kept MongoDB, ElasticSearch, and CockroachDB in the survey to track their usage, despite the fact that their licenses are not compatible with the Open Source Definition, and therefore are not to be considered open source. This year, PostgreSQL took second place among the respondents — passing MongoDB which was the second most popular in last year's survey.

"We kept MongoDB, ElasticSearch, and CockroachDB in the survey to track their usage, despite the fact that their licenses are not compatible with the Open Source Definition and therefore are not to be considered open source."

"The top 3 most used data technologies were MySQL, PostgreSQL, and MongoDB. This year PostgreSQL took second place among the respondents, passing MongoDB."

Outside the options provided for the most popular open source data technologies, almost 2% of respondents indicated Apache Solr as an open source data technology used in their organizations.

Q **Which Open Source Data Technologies (Select All That Apply) Does Your Organization Use Today?**



Breaking down the use of open source data technologies by the size of organizations resulted in some very different results. MySQL had 40.8% usage in small organizations (under 100 employees), which was higher than large organizations (37%) and medium organizations (29%). There were similar stats for PostgreSQL, which showed higher usage among small organizations. In the case of MongoDB, our results showed that large organizations use it at a higher rate than medium and small organizations. This is likely related to enterprise pricing and support outside the scope of open source licenses.

"A higher usage of MySQL and PostgreSQL was evident among small organizations vs. large organizations.

MongoDB obtained a high percentage of use among large organizations."

	MySQL	PostgreSQl	MongoDB
Large (more than 1,000 employees)	36.96%	33.60%	32.32%
Medium (100 to 1,000 employees)	29.42%	28.96%	26.00%
Small (under 100 employees)	40.87%	35.96%	26.97%

When looking at the open source data technologies used by industry, we can see some interesting differences in technology selection, some of which are driven by technologies like artificial intelligence (AI) and machine learning (ML). In some cases, it is likely that the selected technology is only based on legacy and historical use of that technology.

	MariaDB	MySQL	PostgreSQL	Cassandra	MongoDB	CouchDB
Technology	26.52%	48.01%	40.07%	17.64%	36.68%	18.11%
Consulting	15.96%	30.99%	29.11%	22.54%	22.54%	18.31%
Telecommunications	11.56%	20.23%	30.06%	20.23%	26.01%	21.97%
Banking, Insurance, or Financial Services	19.02%	32.61%	26.09%	25.00%	25.54%	15.76%
Education and Research	25.17%	34.44%	33.11%	17.88%	23.84%	20.53%
Vehicle and Transportation	16.20%	10.06%	18.99%	23.46%	23.46%	19.55%
Public Sector/Government	14.06%	31.25%	32.81%	21.09%	21.09%	21.09%
Healthcare and Pharma	17.69%	24.62%	25.38%	20.00%	17.69%	19.23%
Manufacturing	17.89%	18.70%	21.14%	17.07%	13.82%	15.45%
Retail	14.71%	32.35%	23.52%	20.59%	20.59%	5.88%

	CockroachDB	Apache Spark	Apache Hadoop	ElasticSearch	Redis	Apache Kafka
Technology	12.97%	15.07%	12.15%	18.69%	21.50%	19.63%
Consulting	16.43%	10.80%	8.92%	9.39%	12.21%	16.90%
Telecommunications	13.29%	13.87%	8.09%	9.83%	13.29%	20.81%
Banking, Insurance, or Financial Services	13.04%	12.50%	14.67%	17.39%	11.96%	19.02%
Education and Research	12.58%	19.87%	12.58%	15.23%	17.88%	9.93%
Vehicle and Transportation	16.20%	9.50%	6.15%	6.15%	11.73%	16.76%
Public Sector/Government	7.81%	9.38%	4.69%	13.28%	10.94%	17.19%
Healthcare and Pharma	16.15%	13.08%	7.69%	15.38%	9.23%	14.62%
Manufacturing	11.38%	16.26%	5.69%	10.57%	15.45%	13.82%
Retail	11.76%	17.65%	5.88%	14.71%	14.71%	14.71%

	Apache Flink	Hazelcast	InfluxDB	FluentD	Flunet BIT
Technology	13.67%	11.67%	12.03%	6.89%	2.10%
Consulting	15.02%	15.02%	13.62%	7.51%	4.69%
Telecommunications	20.81%	20.81%	11.56%	3.47%	4.05%
Banking, Insurance, or Financial Services	13.04%	13.04%	10.87%	7.07%	3.26%
Education and Research	13.25%	13.25%	12.58%	9.93%	2.65%
Vehicle and Transportation	18.99%	18.99%	9.50%	2.79%	4.47%
Public Sector/Government	15.63%	15.63%	6.25%	6.25%	9.38%
Healthcare and Pharma	14.62%	14.62%	13.85%	10.00%	3.08%
Manufacturing	11.38%	13.82%	14.63%	4.07%	7.32%
Retail	5.88%	14.71%	5.88%	5.88%	2.94%

WHY TEAMS CHOOSE OPEN SOURCE DATA TECHNOLOGIES

After respondents listed the open source data technologies used in their organizations, we asked what they considered important when choosing those technologies. In order of importance, respondents ranked the top five reasons they use their selected open source data technologies.

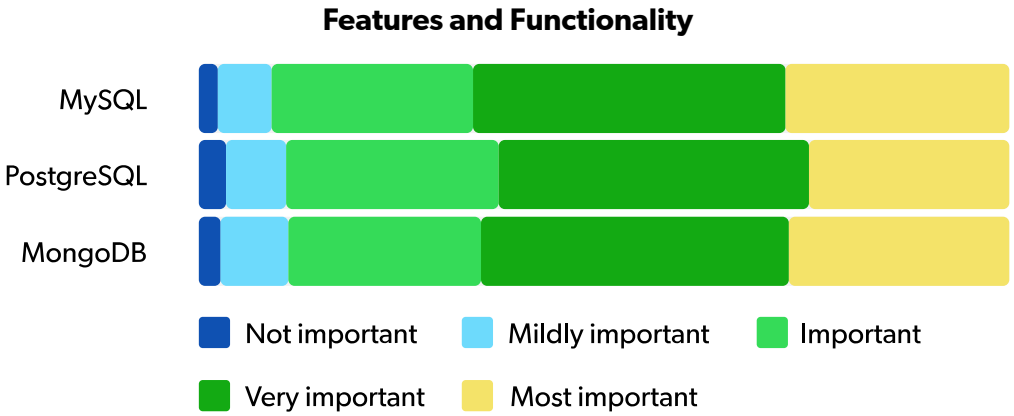
Security and patches were selected as the most important factor for the selection of open source data technologies (26%). This speaks to the need to keep up with the latest patches to address bugs and security vulnerabilities.

At 25%, features and functionality was another important factor for the selection of open source data technologies. Due to the large variety of open source data technologies, this factor is very relevant since users can evaluate and test multiple options to compare functionality.

Q **In Order of Importance, (Not Important — Most Important) Rank the Reasons You Chose This Mix of Data Technologies.**

	Not Important	Mildly Important	Important	Very Important	Most Important
Licensing cost	8.04%	14.71%	27.88%	31.52%	17.85%
Enterprise technical support	8.28%	14.65%	29.03%	30.85%	17.2%
Security and patches	5.73%	10.15%	25.71%	32.48%	25.93%
Level of proficiency and experience	4.73%	12.24%	28.84%	31.85%	22.29%
Features and functionality	5.28%	10.23%	26.92%	32.38%	25.19%

The overall considerations for using open source data technologies did not change significantly based on organization size, which tells us that the market share, functionality, and popularity of these technologies seem to be well defined. As an example, we found that the importance of features and functionality for MySQL, PostgreSQL, and MongoDB were almost identical.



In the case of these factors by industry, the results are different. The following chart shows the industries with the highest percentage selected as the most important factor to use open source data technologies.

- Licensing cost: Education and Research
- Enterprise technical support: Manufacturing
- Security and patches: Technology
- Level of proficiency and experience: Technology
- Features and functionality: Manufacturing

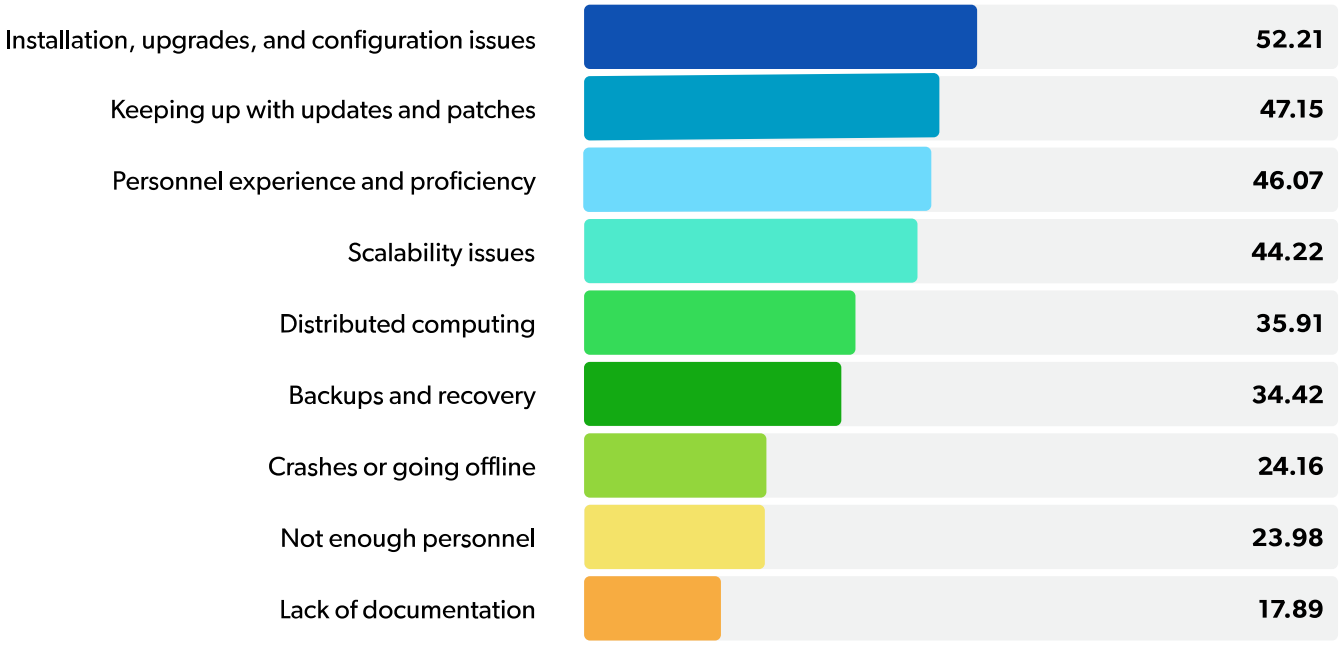
CHALLENGES WITH OPEN SOURCE DATA TECHNOLOGIES

After ranking the top reasons to use selected open source data technologies, we asked about the top support challenges while using those data technologies.

Installations, upgrades, and configuration issues are the most selected challenge on open source data technologies (52%), followed by keeping up with updates and patches (47%), and personnel experience and proficiency (46%). As we have seen throughout this report, these are the most common top three challenges in open source.

Perhaps surprisingly, not having enough personnel ranked low with 24% of the respondents, a significant contrast with the challenge to have personnel experience and proficiency with 46%. We can conclude that there is available personnel, but they are not proficient.

Q What Are the Main Support Challenges for the Open Source Data Technologies You Are Using?



When we look at the same support challenges among respondents working for large organizations (over 1,000 employees) the top three challenges shift — with keeping up with updates and patches as the number one challenge for large organizations.

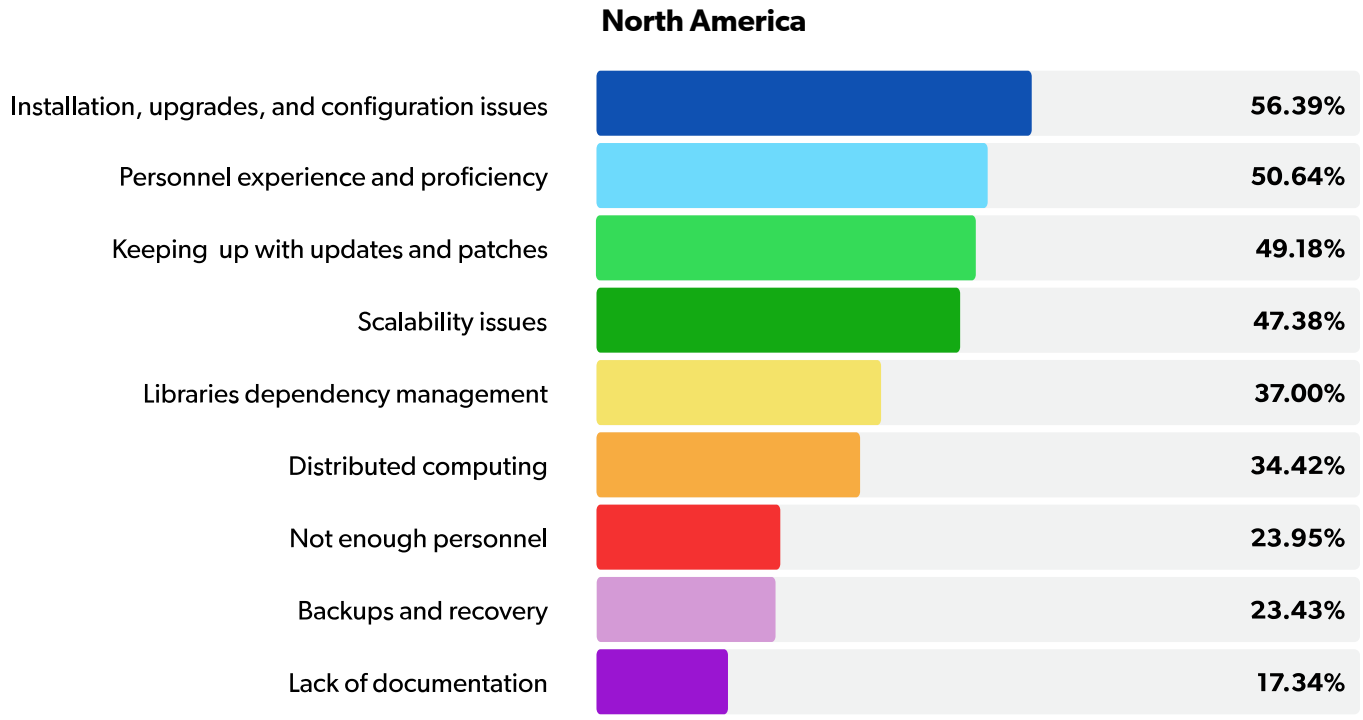
	Most important support challenges for open source data technologies among large organizations:
1.	Keeping up with updates and patches: 51%
2.	Installation, upgrades, and configuration issues: 49%
3.	Personnel experience and proficiency: 46%

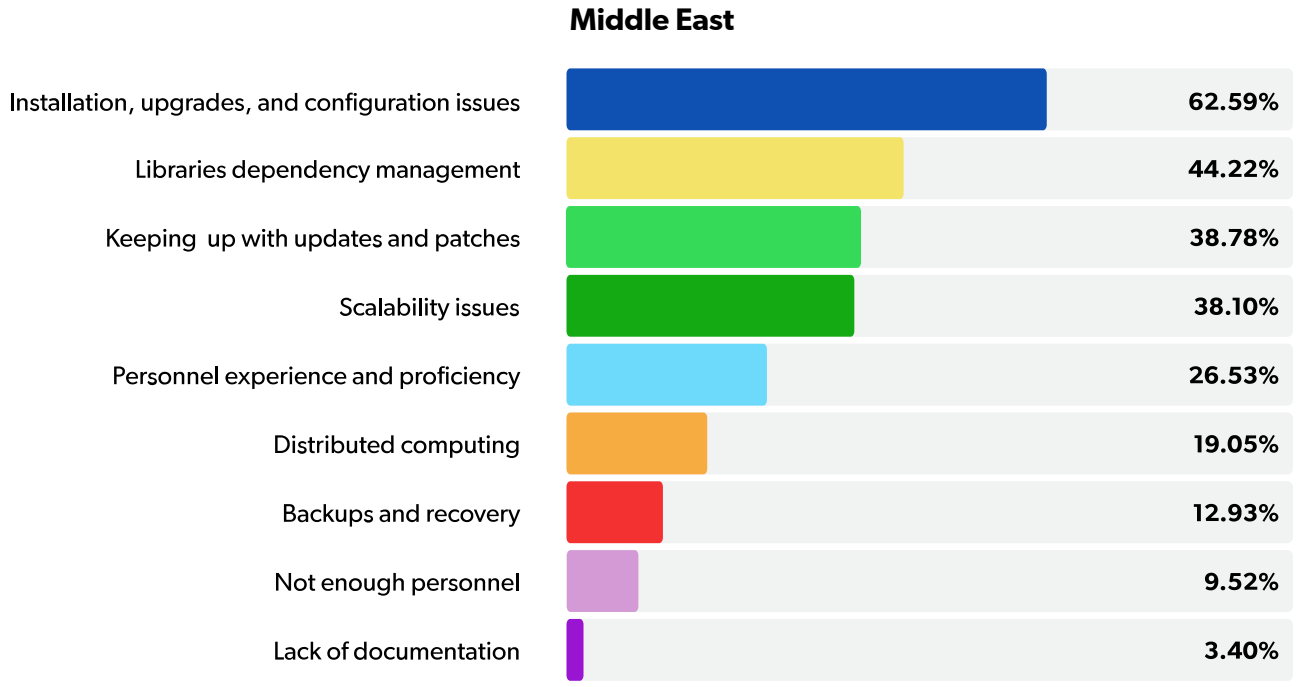
The support challenges for open data technologies by industry varies, the following chart shows the industry with the highest percentage selected on each one of the support challenges:

- Not enough personnel: Healthcare and Pharma 30%
- Personnel experience and proficiency: Education and Research 52%
- Installation upgrades and configuration issues: Vehicle and Transportation 59%
- Keeping up with updates and patches: Retail 62%
- Scalability issues: Retail 62%
- Libraries dependency management: Banking, Insurance, or Financial Services 46%
- Distributed computing: Healthcare and Pharma 44%
- Backups and recovery: Banking, Insurance, or Financial Services 30%

With over 62% of the respondents' selection, the retail industry has two major support challenges with open source data technologies, keeping up with updates and patches, and scalability issues.

Support challenges also varied by region. Notably, North America and the Middle East showed significantly different selections for support challenges when using open source data technologies.





Top Open Source SDLC and Build Technologies

In the category of software development lifecycle (SDLC) and build application technologies, we added more popular open source technologies for this year's survey. It is clear from the results that development teams are using a variety of open source options in their SDLC.

As in previous years, the use of Git repos is popular, but only 37% of the respondents using Git repos seems low. After follow-up research with some of the respondents, we can conclude that the use of Git repos via offerings like GitHub and GitLab are extremely popular. We intentionally focused the State of Open Source survey on open source software, and we tried as much as possible not to include software outside the definition of open source. The use of Git as a free and open source distributed version control system is clearly a leader in the software control management (SCM) space.

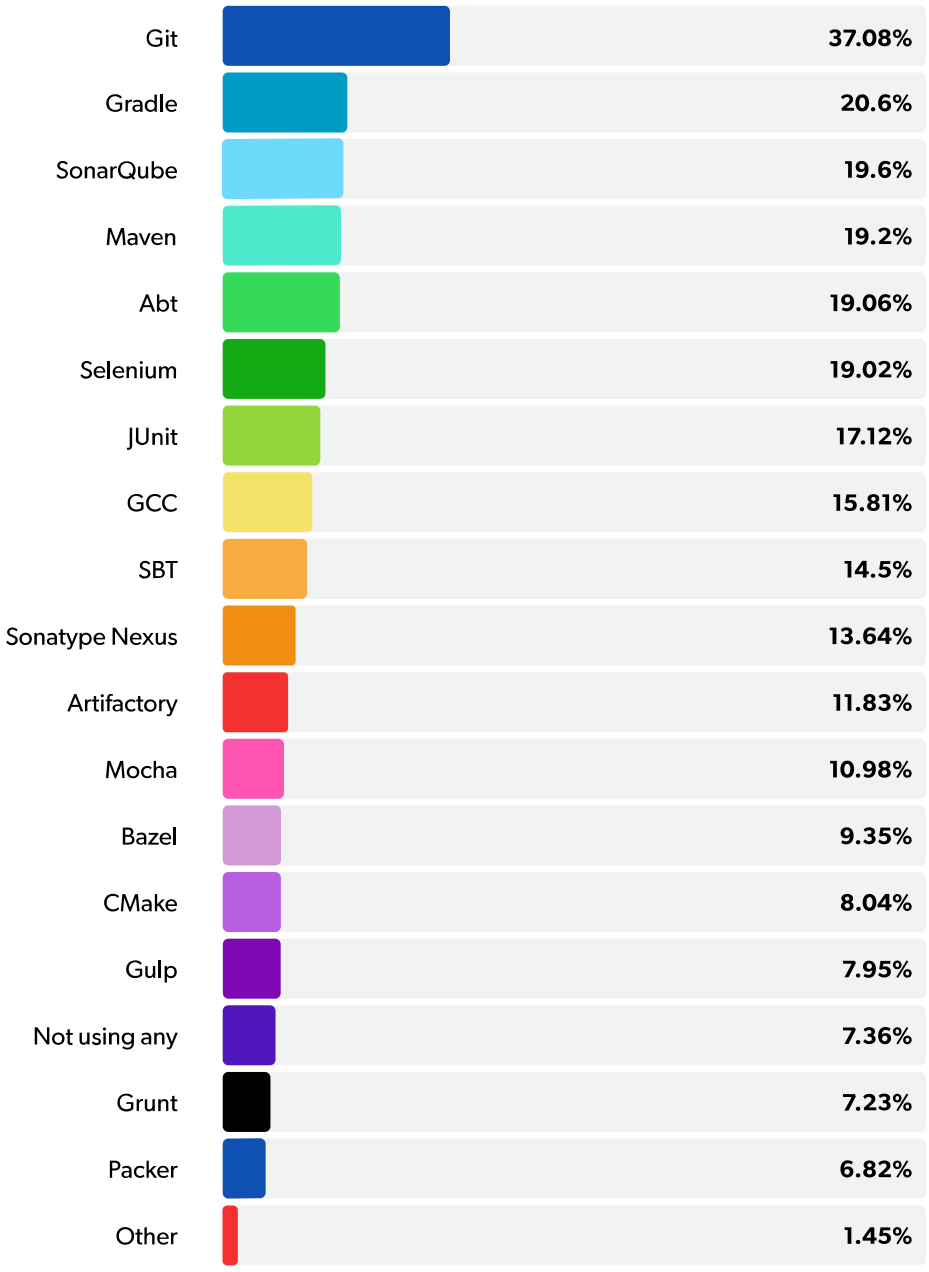
Last year, Maven edged Gradle as the most popular Java build tool, but not this year. Gradle passed Maven as the most used open source Java build tool at 20.6% vs. 19.2%. It will be interesting to see how much this data changes in the next 12 months.

> "Gradle passed Maven as the most used open source Java build tool 20.6% vs 19.2%."

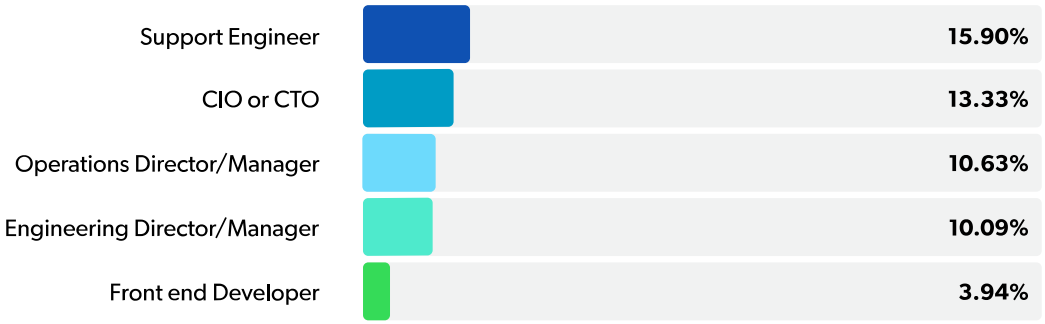
For open source testing tools, the respondents ranked Selenium as the most used open source testing tool (19%), followed by other popular testing frameworks like JUnit and Mocha for Java and JavaScript, respectively.

Webpack and Cargo were also mentioned by a small percentage of respondents (we plan to include them in next year's survey).

Q **Which Open Source SDLC and Build Technologies (Select All That Apply) Does Your Organization Use Today?**



The "Not using any" open source SDLC and build tools option obtained a 7% selection. Does it mean that 7% use only proprietary offerings? Do we have 7% of respondents not using any SDLC tooling? Or, are management roles not aware of the SDLC tooling? To help us answer these questions, we cross referenced the responses based on the job title of the respondents. As expected, roles outside engineering and software development did not select SDLC tooling.



When we break down the use of open source SDLC and build tools by organization size, we find some interesting differences in selection. Not using any tool jumped significantly for small organizations. The use of Git is very even, regardless of the size of the organization. SonarQube, Nexus, and Artifactory are more popular among large organizations.

	Not Using Any	GIT	SonarQube	Sonatype Nexus	Artifactory
Large (more than 1,000 employees)	3.84%	40.00%	25.44%	15.36%	16.96%
Medium (100 to 1,000 employees)	4.68%	31.70%	21.09%	15.39%	10.49%
Small (under 100 employees)	13.76%	41.15%	12.64%	9.97%	8.99%

WHY TEAMS CHOOSE OPEN SOURCE SDLC AND BUILD TECHNOLOGIES

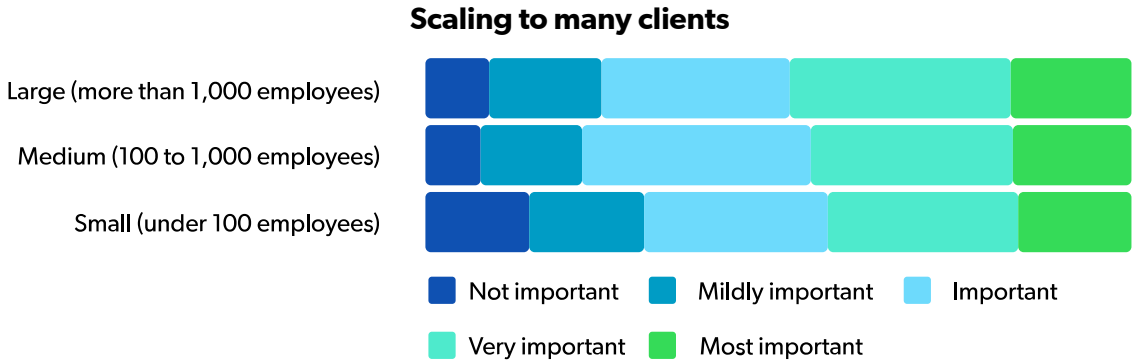
After respondents listed the open source SDLC and build tools used in their organizations, we asked what they considered important when choosing those tools. In order of importance, respondents ranked the top five reasons to use their selected open source SDLC tools.

The top reason was features and functionality of the open source SDLC and build tools, with 26% of respondents reporting it as their most important consideration. Rounding out the top three, ease of use/deployment (a new category this year), and level of proficiency and experience tied at 21%. From the results, we can see that the combination of features and functionality with ease of use are the winning elements for popular open source SDLC and build tools.

Q **In Order of Importance (Not Important — Most Important) Rank the Reasons You Chose This SDLC and Build Technology Mix?**

	Not Important	Mildly Important	Important	Very Important	Most Important
Scaling for many clients	10.38%	15.34%	28.81%	28.81%	16.66%
Enterprise technical support	10.52%	15.76%	30.74%	27.23%	15.76%
Ease of use, deployment	6.92%	11.53%	26.88%	33.12%	21.55%
Level of proficiency and experience	7.74%	12.26%	28.79%	29.93%	21.28%
Features and functionality	7.2%	11.08%	25.11%	30.13%	26.48%

Among the choices, scaling for many clients varied most based on the size of the organization. As expected, respondents from small organization rated scalability as "not important" to a significantly larger degree than medium and large organization. The surprising statistic is that small organizations selected scalability in the same percentage as the "most important" factor. From this, we can infer that some small organizations are growing or have plans for growth, and that scaling the number of clients is a key factor in the selection of open source software for SDLC.



Breaking down the reasons to use open source SDLC and build tools by industry provided a variety of results. The following chart shows the industries with the highest percentage selected as the most important factor when using open source SDLC and build tools.

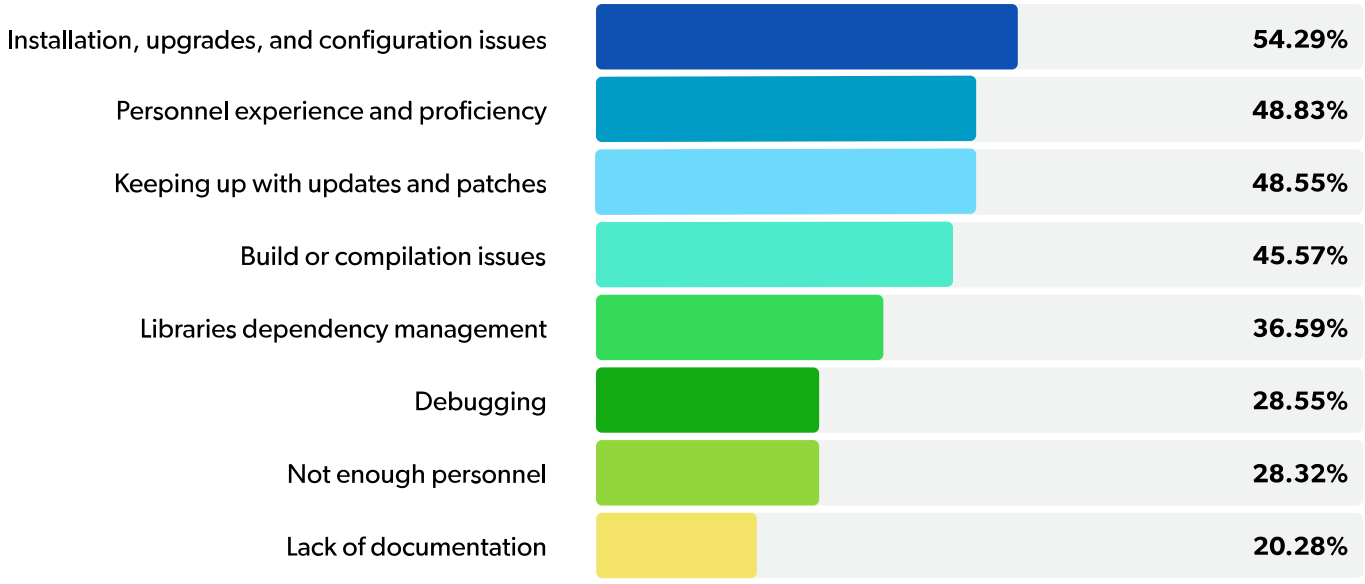
- Scaling for many clients: Manufacturing
- Enterprise technical support: Public Sector/Government
- Ease of use, deployment: Healthcare and Pharma
- Level of proficiency and experience: Technology
- Features and functionality: Technology and Healthcare/Pharma

CHALLENGES WITH OPEN SOURCE SDLC AND BUILD TECHNOLOGIES

After ranking the top reasons to use selected open source SDLC and build tools, we asked about the support challenges they experience while using their selected open source tools.

Installation, upgrades, and configuration issues was selected as the top support challenge at 54%, which ranks high among support challenges for other open source technologies. While the objective of this type of tool is to facilitate software development, there are technical details around installation and configuration that clearly create support challenges. Not surprisingly, the next two top support challenges were a virtual tie, with personnel experience and proficiency, and keeping up with updates and patches each gaining 48% of responses. Not enough personnel in this open source category ranked low, which is similar to the results on data technologies. According to the results, the issue is not resources, it is with experience and proficiency.

Q **What Are the Main Support Challenges for the Open Source SDLC and Build Tools You Are Using?**



For the same support challenges among respondents working for large organizations (over 1,000 employees) the results changed in the top three support challenges.

	Most important support challenges for open source SDLC and build tools among large organizations:
1.	Keeping up with updates and patches: 54%
2.	Installation, upgrades, and configuration issues: 52%
3.	Personnel experience and proficiency: 46%

Support challenges for open source SDLC and build tools by industry also show differences. The Education and Research vertical ranked the highest in four challenges. The following chart shows the industry with the highest percentage selected for each one of the support challenges:

- Not enough personnel: Healthcare and Pharma 30%
- Personnel experience and proficiency: Education and Research 52%
- Installation upgrades and configuration issues: Vehicle and Transportation 59%
- Keeping up with updates and patches: Retail 62%
- Scalability issues: Retail 62%
- Libraries dependency management: Banking, Insurance, or Financial Services 46%
- Distributed computing: Healthcare and Pharma 44%
- Backups and recovery: Banking, Insurance, or Financial Services 30%

Top Open Source Automation and Orchestration Technologies

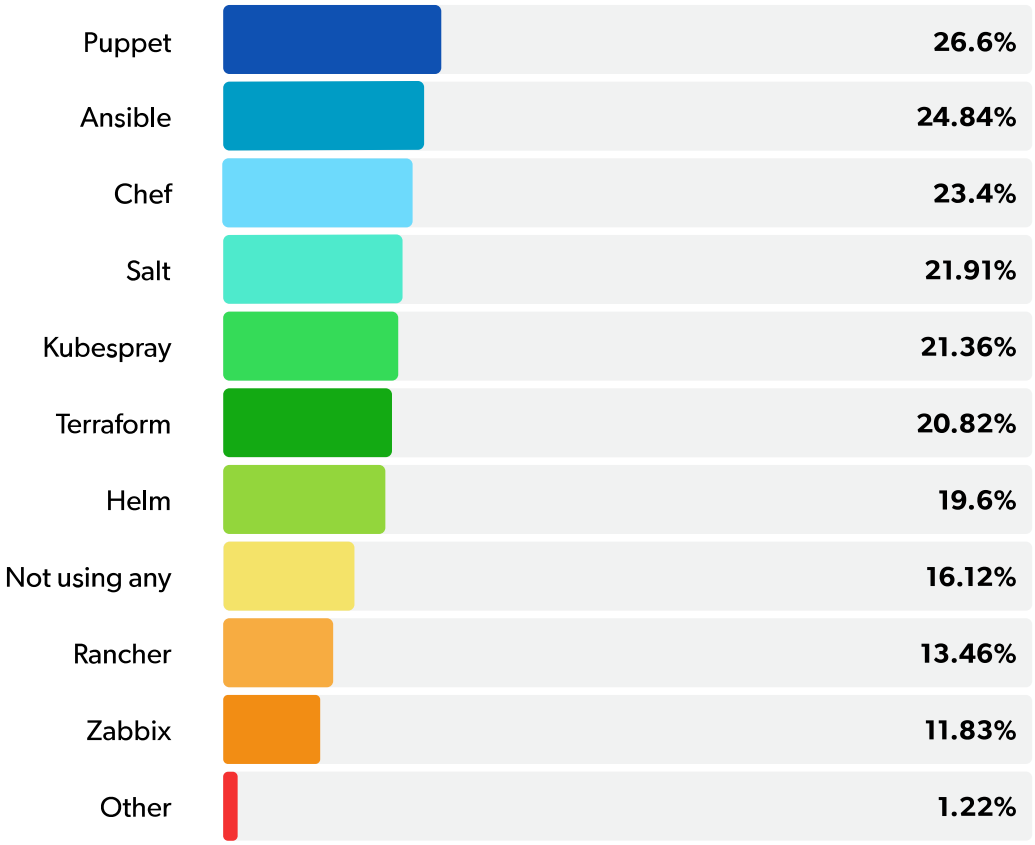
Over the last few years, DevOps has been top of mind for organizations across all industries. This is evident in organizations moving and advancing DevOps initiatives, and the veritable boom of open source software for everything related to DevOps. For this survey, we narrowed the scope to only automation and orchestration, listing only the most popular open source automation and orchestration tools, and leaving open source Continuous Integration (CI) and Continuous Delivery/Deployment (CD) tools in a separate category.

Perhaps owing to the much larger number of responses in this year's survey, we have some major year over year changes. For example, last year 50% of the respondents indicated that they were not using any of the listed tools. This year, it went down to only 16%. Like everything else in open source, there is significant growth and adoption of DevOps related tooling.

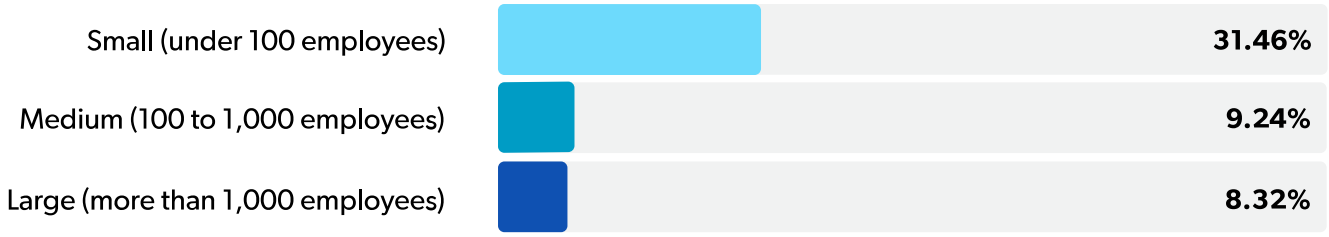
Salt also had a significant increase from last year, jumping up from 7% to 22%. Puppet is the other highlight, surpassing Ansible in the last 12 months in our respondent's usage selection.

> "Last year 50% of the respondents indicated that they were not using automation and orchestration tools. This year, it went down to only 16%."

Q **Which Automation and Orchestration Technologies (Select All That Apply) Does Your Organization Use Today?**



Breaking down the use of automation and orchestration technologies by the size of organizations, we noticed some diverse results. The "not using any" tool option went up to 31% for small organizations, which speaks to not having enough expertise, need, or not using cloud services typically associated with open source automation and orchestration tools.



When we break down the use of open source automation and orchestration technologies by the size of the organization, we found differences in some of the popular options we presented in the survey. Ansible topped Puppet and Chef among large and small organizations, while Puppet was number one among medium organizations.

	Not Using Any	Ansible	Puppet	Chef
Large (more than 1,000 employees)	8.32%	31.36%	30.88%	29.12%
Medium (100 to 1,000 employees)	9.24%	20.52%	31.93%	26.68%
Small (under 100 employees)	31.46%	24.44%	16.29%	14.33%

WHY TEAMS CHOOSE OPEN SOURCE AUTOMATION AND ORCHESTRATION TECHNOLOGIES

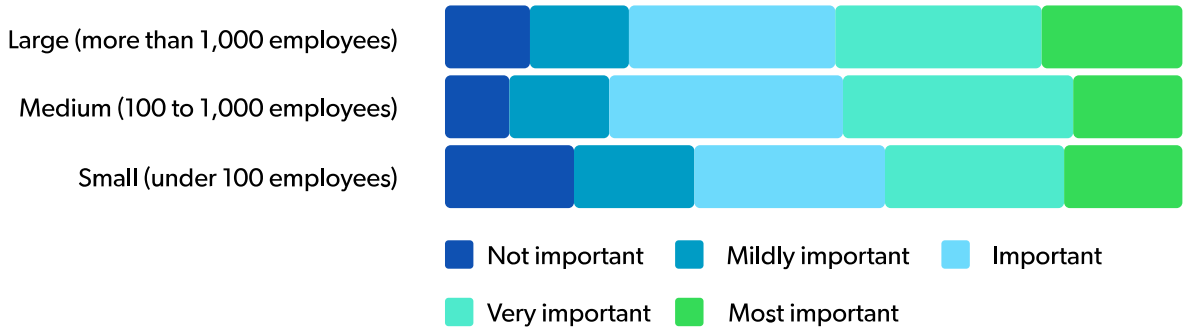
After respondents listed the open source automation and orchestration technologies used in their organizations, we asked what they considered important when choosing those technologies. In order of importance, respondents ranked the top five reasons they use their selected open source automation and orchestration technologies.

As with other new technologies, the top reason was features and functionality at 24%. Security and access control in these technologies received 23% of responses for most important consideration, followed by ease of use/declarative as the third most important consideration at 19%.

Q **In Order of Importance (Not Important — Most Important) Rank the Reasons You Chose This Automation and Orchestration Technology Mix**

	Not Important	Mildly Important	Important	Very Important	Most Important
Scaling for many clients	12.43%	14.39%	28.73%	28.05%	16.39%
Central management	11.36%	12.73%	29.71%	29.30%	16.89%
Security and access control	10.60%	10.69%	25.49%	30.47%	22.75%
Ease of use/declarative	10.00%	10.86%	28.75%	31.22%	19.17%
Features and functionality	9.02%	12.03%	24.84%	29.85%	24.25%

Similar to our findings for open source SDLC and build tooling, the scaling for many clients option provided interesting results based on the size of the organization. Respondents from small organizations rated scalability as "not important" to a significantly larger degree than medium and large organization. At the same time, respondents from small organizations selected scaling for many clients as the "most important" factor. From this, we can infer that some small organizations are growing or have plans for growth, and scaling the number of clients is a key factor in the selection of open source software for automation and orchestration.



Breaking down the reasons to use open source automation and orchestration technologies by industry provided a variety of results. The following chart shows the industries with the highest percentage selected as the most important factor to use open source automation and orchestration technologies.

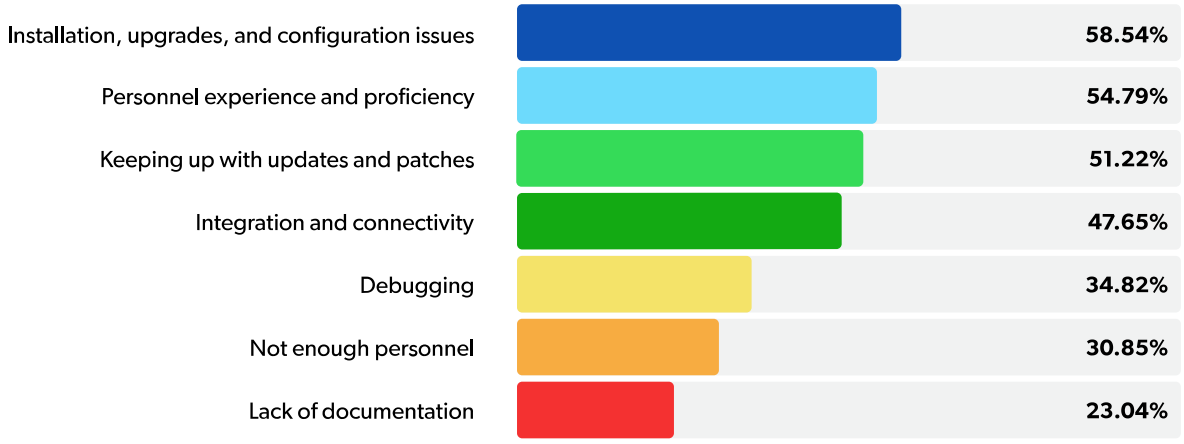
- Scaling for many clients: Manufacturing
- Central management: Public Sector/Government and Technology
- Security and access control: Technology and Healthcare/Pharma
- Ease of use/declarative: Banking, Insurance, or Financial Services, Healthcare/Pharma
- Features and functionality: Healthcare/Pharma

CHALLENGES WITH OPEN SOURCE AUTOMATION AND ORCHESTRATION TECHNOLOGIES

After ranking the top reasons to use selected open source automation and orchestration technologies, we asked about the support challenges while using their selected open source technologies.

Installation, upgrades, and configuration issues were selected as the top support challenge at 58%, which is a high percentage when compared with the top support challenge for other open source technologies. As with all DevOps tools, one of the challenges is that developers have to work with unknown or new tooling, and get stuck during complex installations and configurations. Not every organization has DevOps teams with operations experts in the different automation and orchestration tools. Personnel experience and proficiency ranked as the number two challenge with 55%. Similar to other technologies, keeping up with updates and patches ranked third with 51% of respondents.

Q **What Are the Main Support Challenges on the Open Source Software You Use for Automation and Orchestration?**



For the same support challenges among respondents working for large organizations (over 1,000 employees) the top three challenges changed slightly, with keeping up with updates and patches higher by 1% than personnel experience and proficiency.

	Most important support challenges for open source automation and orchestration technologies among large organizations:
1.	Installation, upgrades, and configuration issues: 59%
2.	Keeping up with updates and patches: 55%
3.	Personnel experience and proficiency: 54%

The support challenges for open source automation and orchestration technologies by industry show some interesting and clearly indicated findings. The following chart shows the industry with the highest percentage selected for each one of the support challenges:

- Not enough personnel: Education and Research 41%
- Personnel experience and proficiency: Technology 57%
- Installation upgrades and configuration issues: Banking, Insurance, or Financial Services 67%
- Keeping up with updates and patches: Healthcare and Pharma 61%
- Integration and connectivity: Banking, Insurance, or Financial Services 57%
- Debugging: Healthcare and Pharma 48%
- Lack of documentation: Education and Research 28%
- Backups and recovery: Banking, Insurance, or Financial Services 30%

Top Open Source CI/CD Tools

When we talk about DevOps tooling, the most recognizable space is open source continuous integration (CI) and continuous delivery/deployment (CD). It's an open source space that continues to grow and a large variety of tools have become popular to automate software development across all industries.

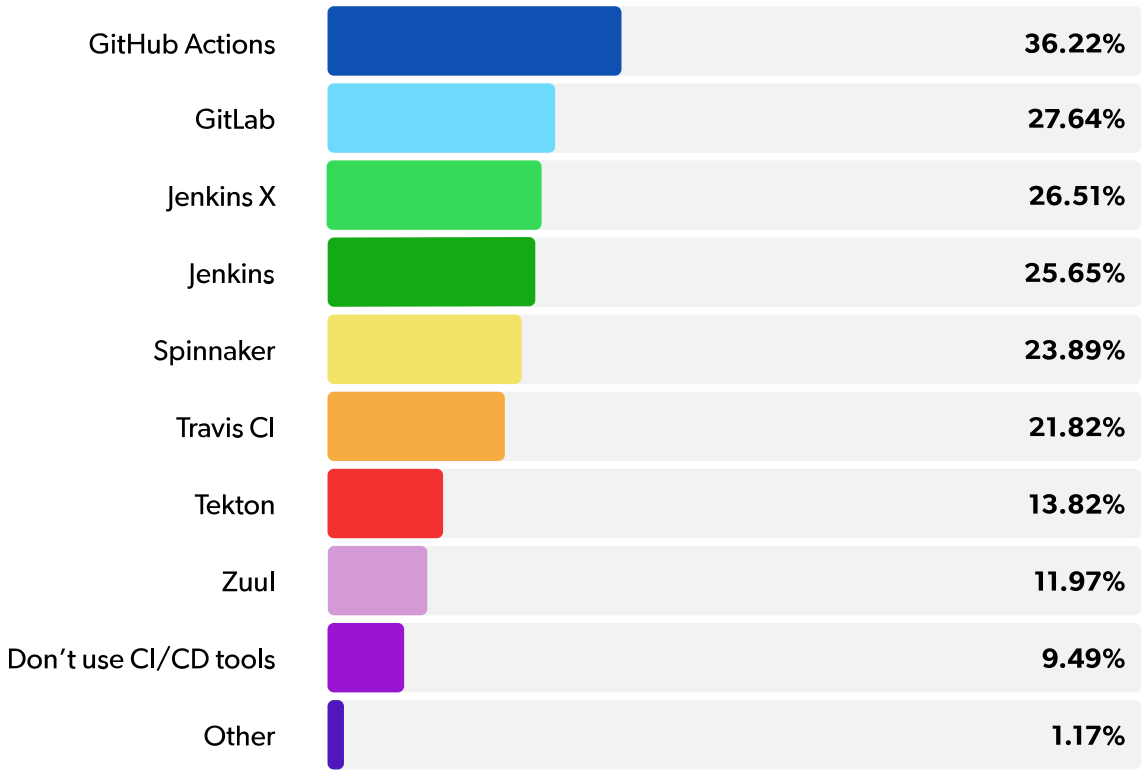
We selected the most popular open source CI/CD tools for this survey and, without limiting the number of selected options, we allowed respondents to select all the open source CI/CD tools used in their organizations.

The survey results show a clear leader — GitHub Actions was selected by 36% of respondents, followed by GitLab (27.6%), Jenkins X (26.5%), and Jenkins (25.6%). One of the highlights in these results is that Jenkins X surpassed Jenkins — which topped open source CI/CD tooling usage for many years. Increased use of containers and Kubernetes has influenced the selection of tooling that run natively in containers like Jenkins X. Other newer or recent tools ranked well with significant percentage of usage, including Spinnaker with 24%, and Tekton at 14%.

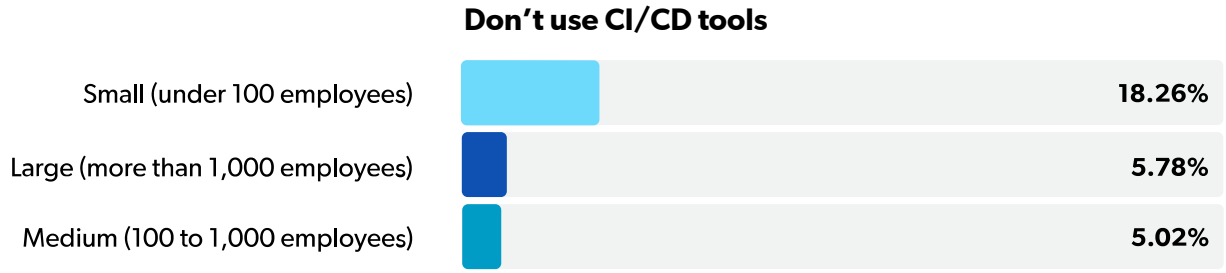
In the "other" category, 1% of respondents listed non-open source tools.

> "Jenkins X passed the popular Jenkins — which toped open source CI/CD tooling usage for many years. Increased use of containers and Kubernetes has influenced the selection of tools that run natively in containers like Jenkins X, Spinnaker, and Tekton."

Q **Which Open Source CI/CD Tools (Select All That Apply) Does Your Organization Use Today?**



The option "Don't use CI/CD tools" obtained a 9% selection. At a macro level, this can be considered a low percentage. For some, it could be surprisingly high. This dissonance is most likely attributable to the differing levels of DevOps maturity within organizations. When we looked at the use of open source CI/CD tooling by the size of the organization, small organizations showed a significantly higher percentage with regards to not using any CI/CD tools.



Reviewing the use of open source CI/CD tooling by industry, we found that Banking, Insurance, and Financial Services, as well as Telecommunications and Public Sector/Government have heavily adopted Jenkins X (33%).

Education and Research industries displayed the largest percentage of respondents not using CI/CD tools, which shows there is room for improvement in the adoption of DevOps practices.

	Don't Use CI/CD Tools	Jenkins	Jenkins X
Telecommunications	5.20%	20.81%	28.32%
Banking, Insurance, or Financial Services	7.07%	23.37%	33.15%
Education and Research	15.23%	23.84%	19.21%
Public Sector/Government	7.81%	22.66%	27.34%
Retail	17.65%	23.53%	11.76%

WHY TEAMS CHOOSE OPEN SOURCE CI/CD TOOLS

After respondents listed the open source CI/CD tools used in their organizations, we asked what they considered important when choosing those tools. In order of importance, respondents indicated the top five reasons they use their selected open source CI/CD tools.

Features and functionality were selected as the most important factor in the selection and use of open source CI/CD tools with 25%. Security and patches (22%) were the second most important factor, followed by level of proficiency and expertise (20%).

Q **In Order of Importance (Not Important — Most Important) Rank the Reasons You Chose This Mix of CI/CD Tooling?**

	Not Important	Mildly Important	Important	Very Important	Most Important
Licensing cost	10.90%	14.21%	29.65%	29.02%	16.21%
Moving to DevOps and automation	7.83%	12.84%	30.13%	30.54%	18.66%
Security and patches	7.93%	11.30%	26.51%	31.66%	22.60%
Level of proficiency and experience	8.38%	11.39%	29.02%	31.48%	19.73%
Features and functionality	7.55%	11.32%	26.77%	29.36%	25.00%

The overall considerations for using open source CI/CD tooling did not change significantly based on the size of the organization. There were very similar results on each one of the five factors for large, medium, and small organizations.

Breaking down these factors and criteria by industry, we can see differences in the reasons why organizations select and use open source CI/CD tooling across different industries. The following chart shows the industries with the highest percentage selected as the most important factor to use open source CI/CD tools:

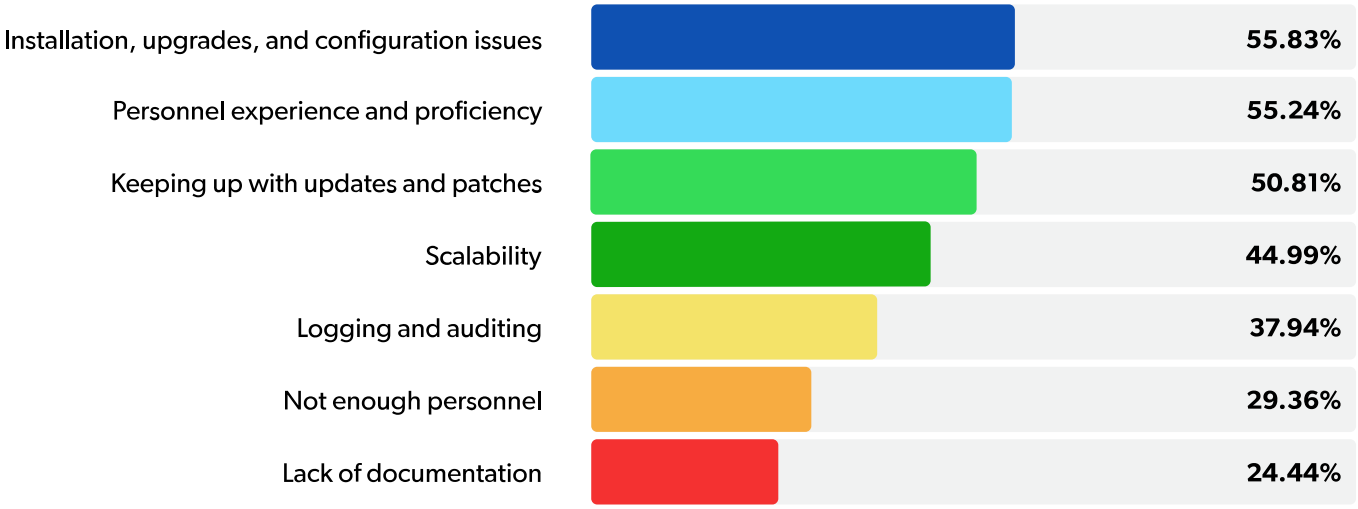
- Licensing cost: Education and Research
- Moving to DevOps and automation: Banking, Insurance, or Financial Services
- Security and patches: Technology
- Level of proficiency and experience: Technology
- Features and functionality: Healthcare/Pharma and Technology

CHALLENGES WITH OPEN SOURCE CI/CD TOOLS

After ranking the top reasons why teams use their selected open source CI/CD tools, we asked respondents to rank the support challenges they face while using their selected CI/CD tools.

For open source CI/CD tools, the top three support challenges were clearly identified and had a similar selection percentage. Installations, upgrades, and configuration issues were the top selection at 55.8%, followed closely by personnel experience and proficiency at 55.2%, and keeping up with updates and patches at 51%. Not enough personnel and scalability presented less of a challenge, according to the respondents.

Q What Are the Main Support Challenges for the Open Source Software You Use for CI/CD?



Looking at the same support challenges based on the respondents' organization size, no major differences were found.

	Most important support challenges for open source CI/CD tools among large organizations:
1.	Personnel experience and proficiency: 57%
2.	Installation, upgrades, and configuration issues: 55%
3.	Keeping up with updates and patches: 54%

The support challenges for open source CI/CD tools varies by industry, the following chart shows the industry with the highest percentage selected on each one of the support challenges:

- Not enough personnel: Education and Research 28%
- Personnel experience and proficiency: Manufacturing 61%
- Installation upgrades and configuration issues: Retail 65%
- Keeping up with updates and patches: Banking, Insurance, or Financial Services 58%
- Scalability: Public Sector/Government 48%
- Logging and auditing: Healthcare and Pharma 49%
- Lack of documentation: Healthcare and Pharma 35%
- Backups and recovery: Banking, Insurance, or Financial Services 30%

Top Open Source Artificial Intelligence Technologies

A new category in this year's State of Open Source survey centers on open source software in artificial intelligence (AI), machine learning (ML), and deep learning (DL). This is a rapidly growing space and one that reaches across the globe. The building blocks of all AI/ML/DL applications are open source components and include everything from frameworks to data technologies that enable model creation, administration, training, and deployment of ML/DL models.

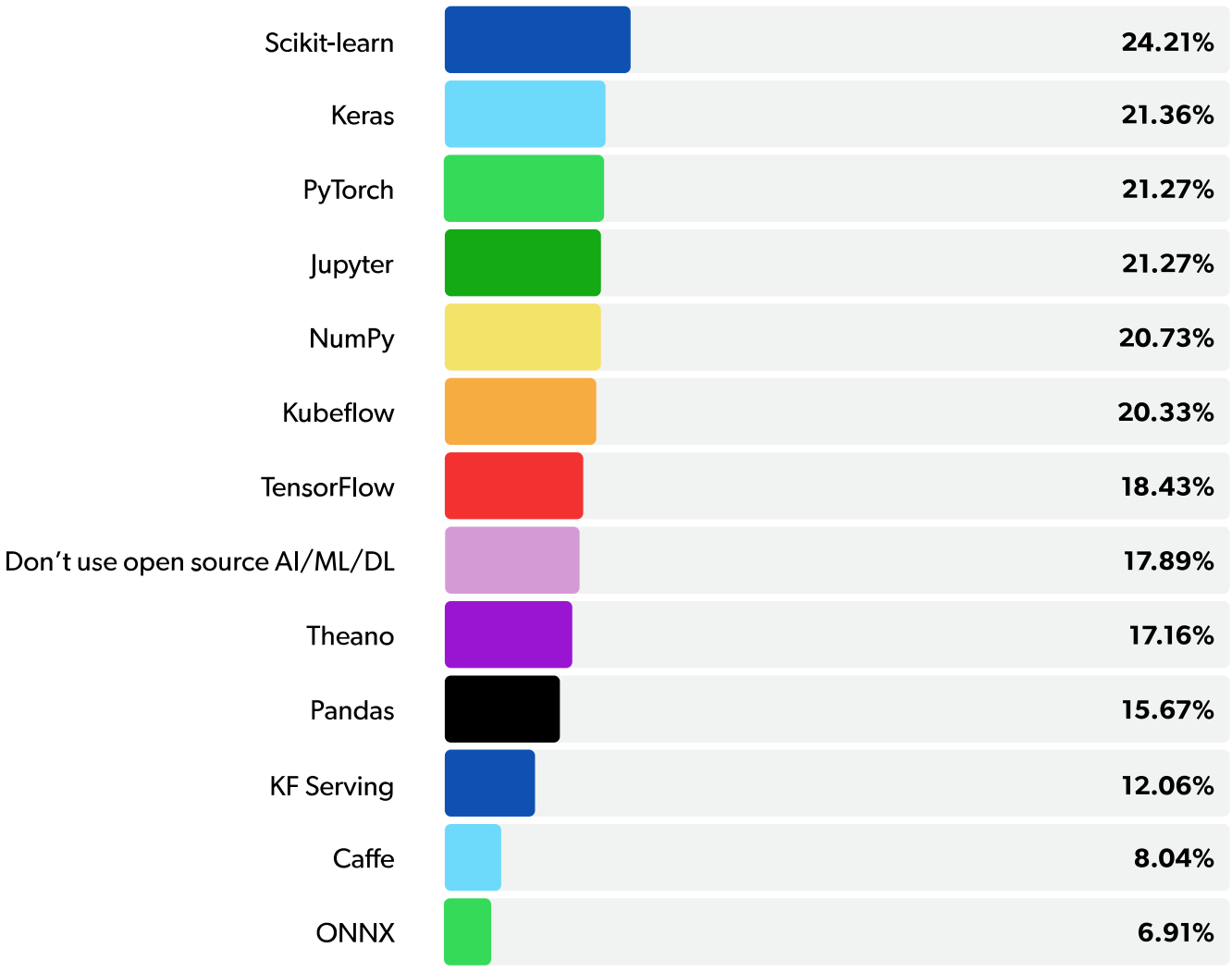
We selected just a few popular open source AI/ML/DL components, and based on the results, it is clear that we must add even more for next year. We can see that there's significant usage of open source components and in the "do not use open source AI/ML/DL" category we obtained only 18% of the respondents. This is very encouraging news for AI/ML/DL open source ecosystem.

> "Very encouraging news for the open source AI/ML/DL ecosystem, only 18% of respondents are not working with AI/ML/DL."

PyTorch (21%) edged TensorFlow (18%) by 3% according to the respondents. Both frameworks dominate the space and it will be interesting to see how their prevalence evolves in future surveys.

Compared to the other popular open source AI/ML/DL options, Pandas had a low percentage of use at only 15%.

Q **Which Open Source AI/ML/DL Technologies (Select all That Apply) Are You Using Today?**

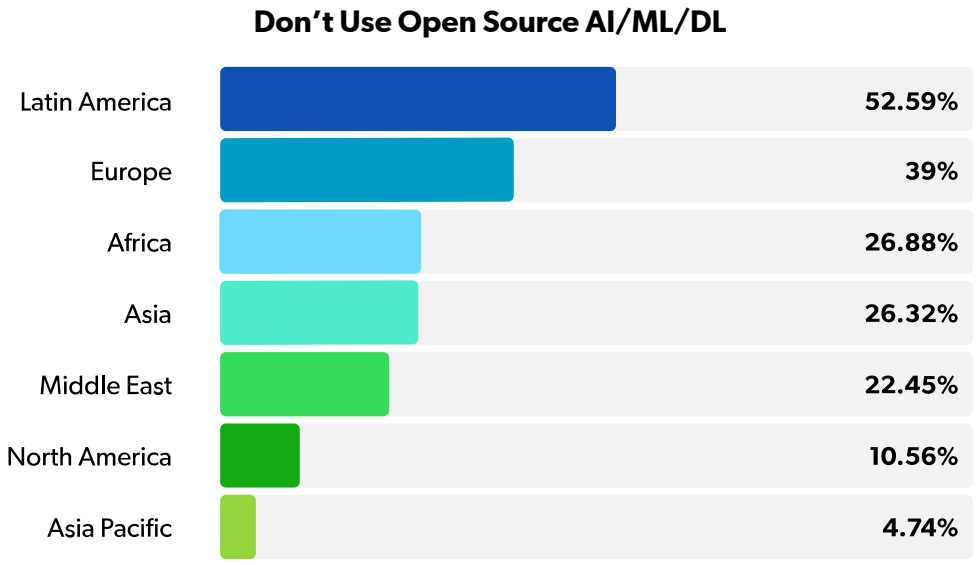


Breaking down the use of open source AI/ML/DL components by the size of organizations, we can see some diverse results. The "not using open source AI/ML/DL" option went up to 30% for small organizations, which tells us that one thirds of small organizations are not investing in AI yet.

PyTorch and TensorFlow usage by organization size shows that large organizations are doing more AI/ML/DL, with medium and small organizations adopting these technologies at lower rates.

	Don't Use Open Source AI/ML/DL	TensorFlow	PyTorch
Q2: Large (more than 1,000 employees)	13.92%	23.84%	23.84%
Q2: Medium (100 to 1,000 employees)	10.95%	15.05%	20.64%
Q2: Small (under 100 employees)	29.92%	17.84%	19.80%

Looking at these results from a regional perspective we can clearly see some regions with a lower adoption rate. The Asia Pacific region had only 5% of respondents indicate that they do not use open source AI/ML/DL.



WHY TEAMS CHOOSE OPEN SOURCE ARTIFICIAL INTELLIGENCE TECHNOLOGIES

After respondents listed the open source AI/ML/DL components used in their organizations, we asked what they considered important when choosing those technologies. In order of importance, respondents ranked the top five reasons they use their selected open source AI/ML/DL components.

As with other new technologies, the top reason was features and functionality of open source AI/ML/DL components, with 24% of respondents reporting it as their most important consideration. Security and patches ranked second, receiving 20% of responses, followed by level of proficiency and experience as the third most important consideration at 19%.

Q **In Order of Importance, (Not Important — Most Important) Rank the Reasons You Chose This Mix of AI/ML/DL Software?**

	Not Important	Mildly Important	Important	Very Important	Most Important
Licensing cost	13.35%	15.24%	28.55%	27.16%	15.70%
Ease of use	10.70%	13.08%	29.50%	29.08%	17.64%
Security and patches	11.30%	12.33%	26.20%	29.75%	20.41%
Level of proficiency and experience	12.10%	11.36%	26.33%	30.55%	19.66%
Features and functionality	10.73%	10.32%	25.88%	29.04%	24.02%

When we look at this data based on the respondent's organization size, the top five considerations for the use open source AI/ML/DL did not change significantly.

Breaking down these factors by industry, we can see differences in why teams select and use open source for AI/ML/DL. The following chart shows the industries with the highest percentage selected as the most important factor to use open source AI/ML/DL components:

- Licensing cost: Education and Research
- Ease of use: Consulting and Banking, Insurance, or Financial Services
- Security and patches: Technology
- Level of proficiency and experience: Education/Research and Vehicle/Transportation
- Features and functionality: Manufacturing

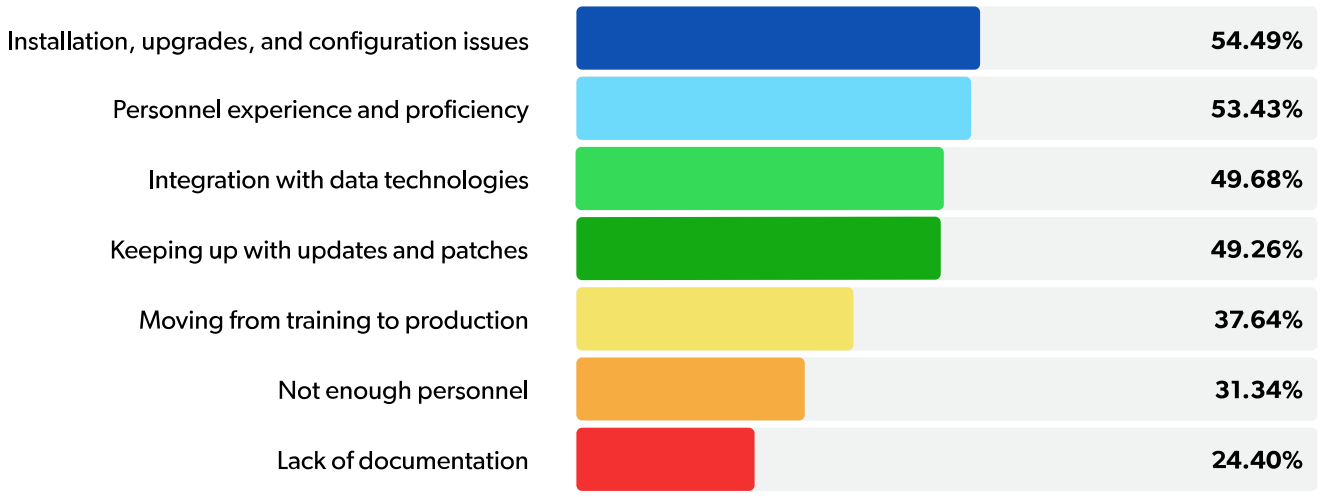
CHALLENGES WITH OPEN SOURCE ARTIFICIAL INTELLIGENCE TECHNOLOGIES

After ranking the top reasons to use selected open source AI/ML/DL components, we asked respondents about the support challenges they face with their selected components.

In the open source AI/ML/DL components category there were four top support challenges with a similar selection percentage. This is the only open source type where we had a virtual top-four tie. Installations, upgrades, and configuration issues were the top selection at 54.4%, followed closely by personnel experience and proficiency with 53.4%, then integration with data technologies 49.6%, and keeping up with updates and patches at 49.2%.

Seeing installation, configuration, and personnel experience listed highly isn't surprising, but a key difference for this category is integration with data technologies is also a clear support challenge. It is well known in AI/ML/DL that cleaning and managing data takes a lot of time and effort. When you add in integration issues, this is an area that clearly requires further improvement and development.

Q **What Are the Main Support Challenges for the Open Source Software You Use for AI/ML/DL?**



Support challenges based on the respondent organization size yielded similar results overall. Integration with data technologies was particularly higher for large organizations (55%) vs. medium (49%) and small organizations (45%).

	Most important support challenges for open source AI/ML/DL components among large organizations:
1.	Integration with data technologies: 55%
2.	Installation, upgrades, and configuration issues: 55%
3.	Personnel experience and proficiency: 53%
4.	Keeping up with updates and patches: 52%

The support challenges for open source AI/ML/DL components varies by industry. The following chart shows the industry with the highest percentage selected on each one of the support challenges:

- Not enough personnel: Education and Research 40%
- Personnel experience and proficiency: Manufacturing 60%
- Installation upgrades and configuration issues: Vehicle and Transportation 66%
- Keeping up with updates and patches: Banking, Insurance, or Financial Services 60%
- Integration with data technologies: Healthcare and Pharma 60%
- Moving from training to production: Healthcare/Pharma and Manufacturing 48%
- Lack of documentation: Healthcare/Pharma and Manufacturing 31%
- Backups and recovery: Banking, Insurance, or Financial Services 30%

Open Source Priorities, Strategy, Maturity, and Stewardship

OPEN SOURCE PRIORITIES

To start our final section of this year's State of Open Source Report, we asked a question about open source priorities. Specifically, we asked about what is not already available in their organizations and their desire to work with modern open source technologies.

The question provided a list of popular, new open source technologies and asked respondents to rank their desire to use these new technologies from most important to not important.

Our survey found that organizations want to add a variety of new open source to their stacks, with a nearly even preference for adding Kubernetes, IoT / edge computing, data science, and AI/ML/DL technologies. The use of Kubernetes or Kubernetes Operator had the highest number of most important selections with 18.6%. IoT and edge computing received a close 18.1% on the most important category, while Data Science and AI/ML/DL both received 17% of responses.

The highest percentage of "not important" selection went to nonfungible tokens (NFT) at 19% and quantum computing at 18%. What this means is that for some respondents these two technologies are not important for the future of their organizations, or may not have been considered at all. Note that these two technologies also received over 20% of "very important" selection.

The larger takeaway is that all of these new technologies are under consideration, and we expect to see more use and growing open source projects and communities in these areas.

	Not Important	Mildly Important	Important	Very Important	Most Important
Data Science	10.21%	15.23%	26.08%	30.82%	17.66%
Artificial Intelligence / Machine Learning / Deep Learning	8.66%	15.69%	29.23%	29.37%	17.05%
Virtual Reality or Augmented Reality	15.03%	15.12%	26.59%	27.82%	15.44%
Kubernetes or Kubernetes Operators	9.90%	12.86%	29.61%	28.97%	18.66%
Blockchain / Crypto	15.06%	16.53%	25.39%	26.54%	16.48%
Nonfungible Tokens (NFT)	19.05%	15.59%	25.42%	26.85%	13.10%
Serverless / Functions	9.29%	14.42%	28.85%	29.90%	17.54%
IoT or Edge Computing	11.89%	14.36%	27.49%	28.13%	18.12%
Data Fabric	12.58%	15.48%	28.29%	26.77%	16.87%
Quantum Computing	18.00%	14.97%	25.67%	23.92%	17.45%

OPEN SOURCE MATURITY

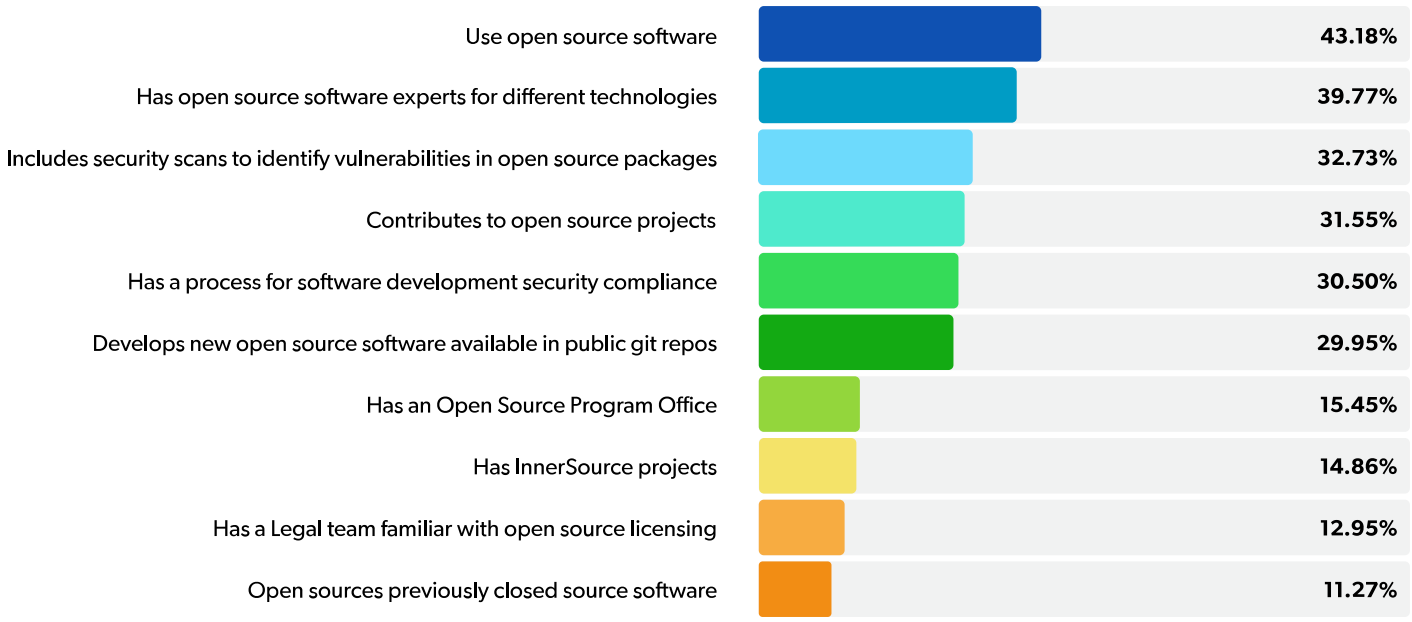
With all the survey information by open source technology types complete, the final step is to inquire about the software strategy and open source maturity in organizations. While everyone is a consumer and user of open source software, organizations have taken steps at different levels to use and invest in open source. We used this question to assess the maturity of processes, as well as human and monetary investments in open source.

We selected 10 activities to classify the level of open source maturity, ranging from entry-level activities like using open source, to more mature activities like contributing to open source projects, or having a defined strategy for open source. One of the stats that stood out immediately was the 43% use of open source, which seems low. But we know that, for the most part, only engineers/developers are considering the use of open source libraries and dependencies in their response if they are already using open source software in some capacity.

31% indicated they are contributing to open source projects, which highlights the desire to fix and improve innovation in open source software. Seeing security scans and security compliance at over 30% also provides a view of what organizations are doing to avoid vulnerabilities and future exploits to vulnerabilities.

The lowest response percentage went to having a legal team familiar with open source licensing at 13%. Organizations like the Open Source Initiative (OSI) are working with communities to create more awareness around open source licensing, and to instill a higher degree of open source maturity within organizations. These efforts should help improve the adoption of Open Source Program Offices (15%) and improve the number of legal teams familiar with open source licensing.

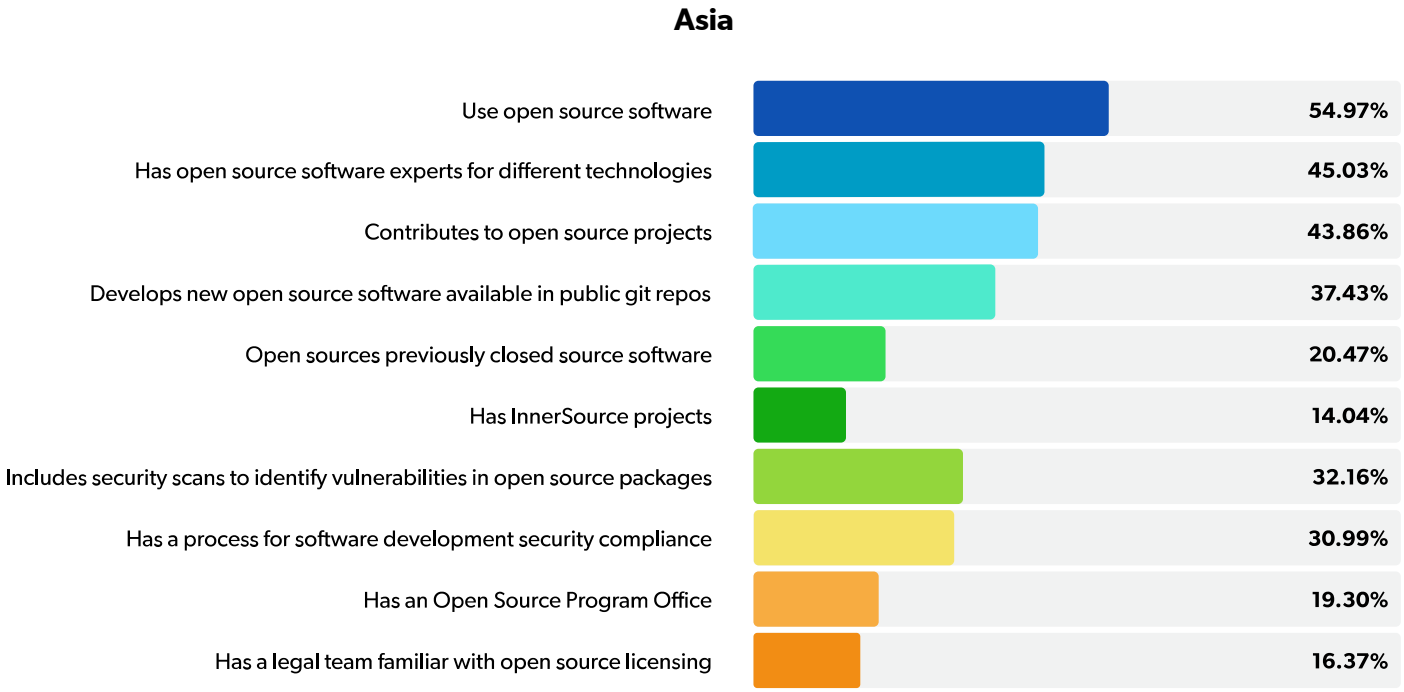
"Consumption of and contribution to open source software are not the only factors that define organizational open source maturity. Security, Open Source Program Office and legal teams familiar with open source licenses are also good indicators of that maturity."



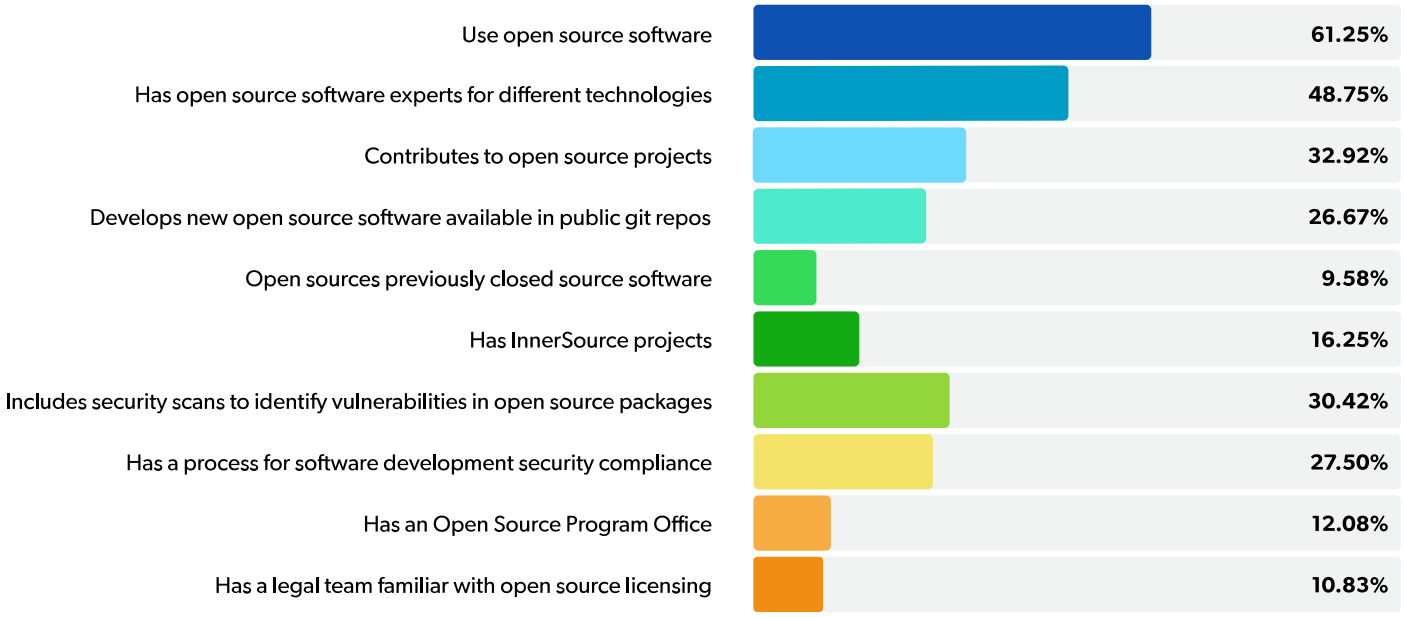
The level of open source maturity at a regional level shows some similarities and some differences. The North America region shows very similar results to the global totals shown in the previous chart. Asian and European regions show that, while the trend in the selection of maturity activities follows the same pattern, their selection has higher percentages across the board. For example, our survey found that 61% of European respondents use open source software vs. a 43% global average. We also found that Asia contributes at a higher rate to open source (44%) than the global average (31%).

"In the UK and Europe, 61% of the respondents use open source software in their organizations vs. a 43% global average."

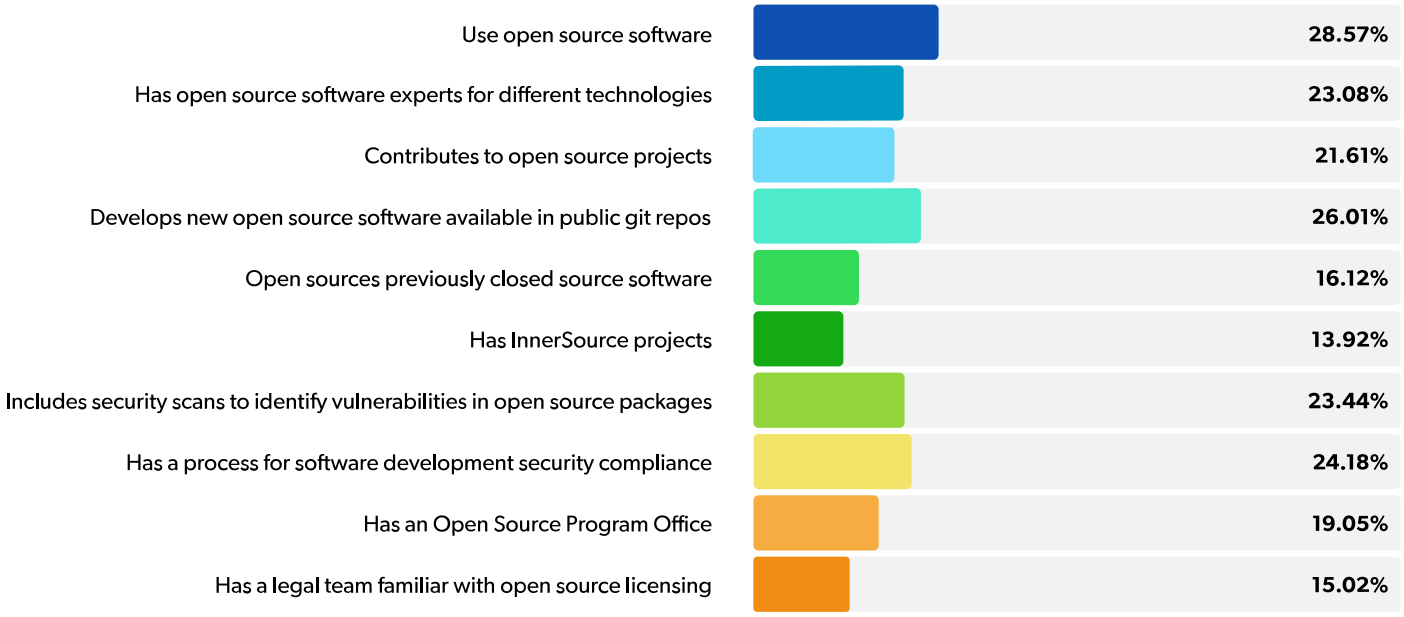
"Asia respondents show contributions to open source at 44% vs. a 31% global average."



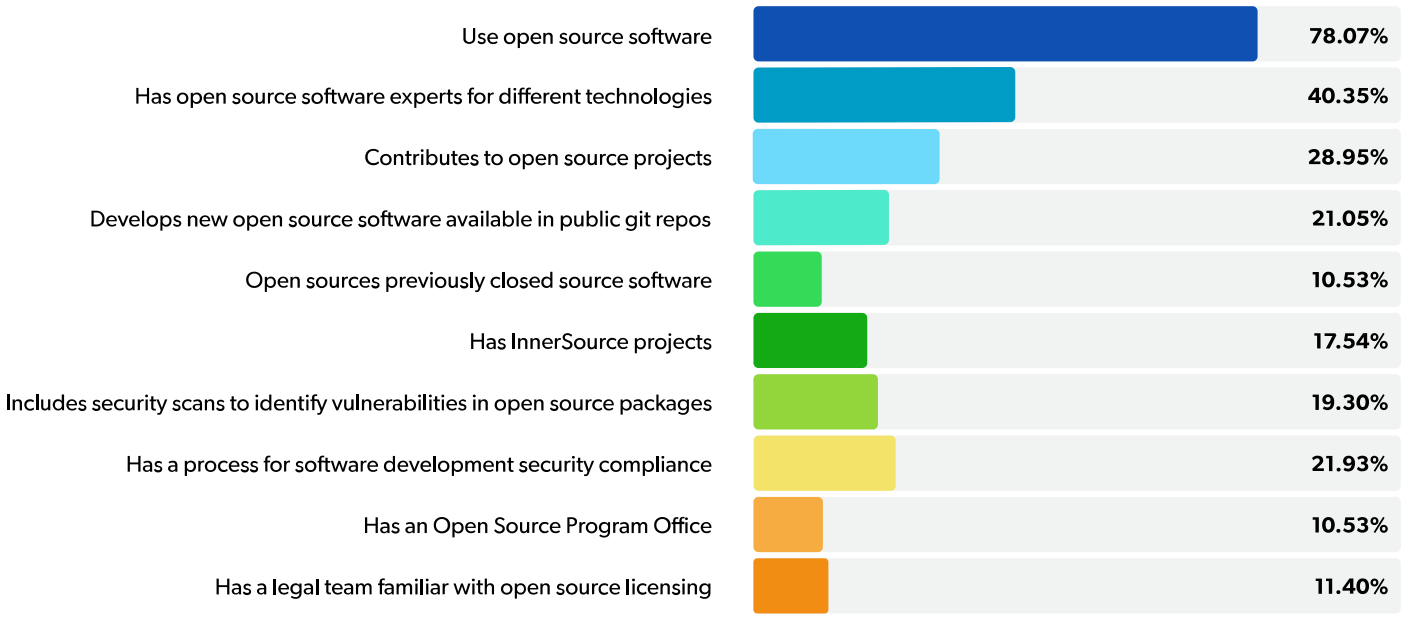
Europe



Asia Pacific



Latin America



Across industries, we see some differences in these activities around open source. A few highlights include very high open source usage within the retail industry (60%), which surpisingly outpaces the technology industry (56%). Manufacturing and healthcare/pharma industries show a low rate of open source usage (<30%).

"The healthcare and pharma industries have the highest percentage of organizations with an Open Source Program Office."

While some industries contribute to open source more than others, the retail industry shows only 9% of the respondents in this industry contributing to open source projects. The banking, insurance, or financial services industry has the highest participation in InnerSource projects among all other industries. The healthcare and pharma industry showed the highest number of Open Source Program Offices, and, perhaps connectedly, the highest number of legal teams familiar with open source licensing.

"The banking, insurance, and financial services industries have the highest participation in InnerSource projects among all other industries. This speaks to the adoption of open source models and best practices for software that is closed source."

	Use Open Source Software	Has Open Source Software Experts for Different Technologies	Contributes to Open Source Projects	Develops New Open Source Software Available in Public GIT Repos	Open Sources Previously Closed Source Software
Technology	56.65%	46.76%	35.57%	33.22%	11.66%
Consulting	36.02%	36.97%	36.49%	25.59%	11.85%
Telecommunications	21.51%	42.02%	29.65%	31.40%	13.37%
Banking, Insurance, or Financial Services	34.78%	34.78%	32.07%	26.62%	6.52%
Education and Research	44.37%	41.06%	32.45%	33.77%	11.26%
Vehicle and transportation	27.53%	37.08%	24.16%	33.15%	11.80%
Public Sector/Government	27.56%	33.86%	29.13%	26.77%	11.81%
Healthcare and Pharma	35.38%	29.23%	25.38%	31.54%	11.54%
Manufacturing	30.33%	22.95%	22.95%	20.49%	12.30%
Retail	60.61%	30.30%	9.09%	12.12%	3.03%

	Has InnerSource Projects	Includes Security Scans to Identify Vulnerabilities in Open Source Packages	Has a Process for Software Development Security Compliance	Has an Open Source Program Office	Has a Legal Familiar with Open Source Licensing
Technology	16.49%	33.57%	33.33%	15.08%	15.43%
Consulting	9.95%	36.97%	26.07%	10.90%	14.69%
Telecommunications	13.37%	32.56%	35.47%	12.21%	9.88%
Banking, Insurance, or Financial Services	19.02%	36.96%	35.87%	17.39%	13.04%
Education and Research	13.91%	26.49%	20.53%	19.21%	11.26%
Vehicle and transportation	14.61%	28.09%	31.46%	14.61%	8.43%
Public Sector/Government	14.96%	29.92%	21.26%	18.11%	7.87%
Healthcare and Pharma	13.85%	30.77%	27.69%	21.54%	11.54%
Manufacturing	11.48%	30.33%	29.51%	18.85%	12.30%
Retail	12.12%	36.26%	27.27%	12.12%	9.09%

OPEN SOURCE STEWARDSHIP

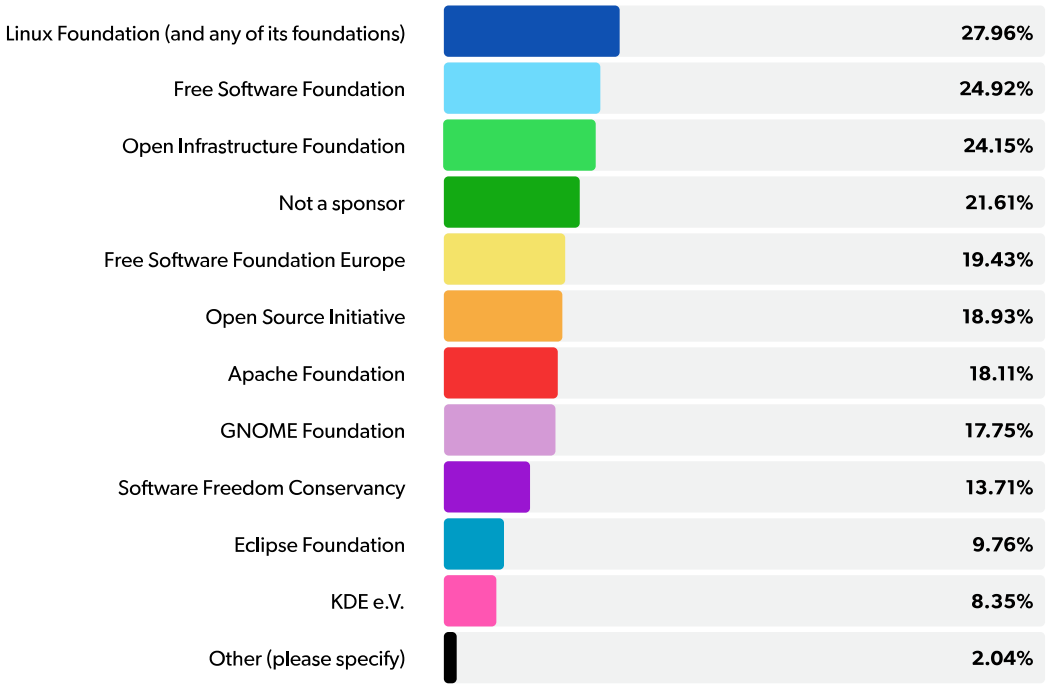
Another important factor in open source maturity is community participation. Mature organizations in open source give back, contribute, and are involved in sponsorships of non-profit open source organizations. We asked respondents to share details regarding their participation in, and sponsorship of, the most popular organizations in the open source space.

Since 21% of respondents reported not being a sponsor, the other 79% of respondents sponsor and/or support open source organizations or open source projects.

Our survey found that the Linux Foundation (with all its member foundations) received the highest percentage of sponsorships at 28%, followed by the Free Software Foundation at 25%, and the Open Infrastructure Foundation in third at 24%. The Open Source Initiative (OSI) obtained a 21% sponsorship among all respondents.

Other organizations mentioned in the "other" section included sponsoring individual open source projects.

Q **Do You or Your Organization Sponsor any Open Source Non-Profit Organization?**



It was not surprising to see small organizations with a lower percentage of sponsoring open source organizations. That said, only 31% said they do not sponsor an open source organization. Overall, we saw good participation and sponsorships regardless of the size of the organization.

	Not a Sponsor	Open Source Initiative
Large (more than 1,000 employees)	18.71%	20.16%
Medium (100 to 1,000 employees)	15.48%	19.72%
Small (under 100 employees)	31.65%	16.88%

TECHNOLOGY STRATEGY

We end the 2022 State of Open Source survey with a question about technology strategy. As we have seen across all industries in these survey results, open source software is ubiquitous and should be ingrained within every technology strategy.

For this question, we identified commonly used technology strategies and asked respondents if their organizations have those strategies. This approach presented us with interesting results about the priorities in organizations around technology (all including open source), what they are pursuing, and what they are not investing in from a monetary and human resources perspective.

Having a strategy, or at least indicating to employees that they are following a technology strategy, motivates opportunities for the use, contribution, and creation of open source software. Some of these technology strategies have been around for a long time, others are more recent or haven't caught on yet with the majority of the organizations.

Keeping in mind that open source software feeds all these strategies, we found that a cloud strategy was the most selected strategy, representing 39% of respondents. In second, 36% reported having an open source strategy. Rounding out the top three technology strategies, 36% reported having an infrastructure modernization strategy. API-first (33%) and containerization strategies (29.5%) were the fourth and fifth most selected strategies, while a "keep the lights on" strategy ranked last at 10%.

These findings are encouraging and show that the wide majority of organizations are looking to push their technology strategies forward, with only a small percentage of organizations content with "keeping the lights on."

Q **What type of technology strategy does your organization have?**

When we break down the different technology strategy results by organization size, we found some interesting highlights. Small organization top open source strategy at 41%, which is 10% higher than medium organizations, and higher than large organizations. API-first and cloud strategies received basically equal percentages regardless of the size of the organization. We also noted more AI/ML and edge computing/IoT strategies among large organization. Interestingly, the "keep the lights on" strategy is very equal, around 10% for organizations of all sizes.

"Smaller organizations tended to be open source strategy-focused, while larger organizations were more focused on cloud and container-centric strategies."

	Open Source Strategy	API-First Strategy	Cloud Strategy	Container-ization Strategy	Artificial Intelligence/ Machine Learning Strategy	Low Code/ No Code Strategy	Infrastructure Modernization Strategy	Edge Computing/ IOT Strategy	Keep the Lights On, No New Technology
Large	36.77%	32.58%	41.94%	35.81%	21.94%	19.35%	37.26%	27.10%	10.97%
Medium	31.95%	32.53%	38.85%	27.13%	16.09%	14.71%	37.59%	23.45%	9.43%
Small	41.16%	33.95%	36.35%	27.02%	18.39%	17.40%	32.67%	19.38%	10.75%

Reviewing technology strategy by industry, we can see some differences — including some industries that are more focused on specific technology strategies. The following chart shows the industries with the highest percentage selected on each one of the technology strategies, with the caveat that we excluded the technology industry because it tops seven of the nine strategy options:

- Open Source strategy: Education and Research 38%
- API-First strategy: Banking, Insurance, or Financial Services 33%
- Cloud strategy: Banking, Insurance or Financial Services, and Education/Research 42%
- Containerization strategy: Public Sector/Government and Telecommunications 30%
- AI/ML strategy: Manufacturing 24%
- Low code/No code strategy: Vehicle and Transportation 20%
- Infrastructure modernization strategy: Vehicle/Transportation and Consulting 39%
- Edge computing/IoT strategy: Telecommunications 33%
- Keep the lights on, no new technology strategy: Healthcare/Pharma and Retail 15%

ABOUT OPENLOGIC

OpenLogic by Perforce provides end-to-end enterprise support and services for organizations using open source software in their infrastructure.

With support for over 450 open source packages, guaranteed SLAs, and direct access to highly-experienced Enterprise Architects, OpenLogic customers receive a consolidated and holistic open source support solution through our 24x7 ticket-based support, professional services, and training.

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ABOUT THE OPEN SOURCE INITIATIVE

The Open Source Initiative (OSI) is the steward of the Open Source Definition, setting the foundation for the global open source ecosystem. Founded in 1998, OSI protects and promotes open source software, development and communities, championing software freedom in society through education, collaboration and infrastructure. The OSI is a 501(c)3 non-profit, and anyone interested in supporting the defense of Open Source Definitions can join today at https://join.opensource.org.

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