Open Source and InnerSource Skills in Ireland: A Call for Action

Technology Ireland ICT Skillnet

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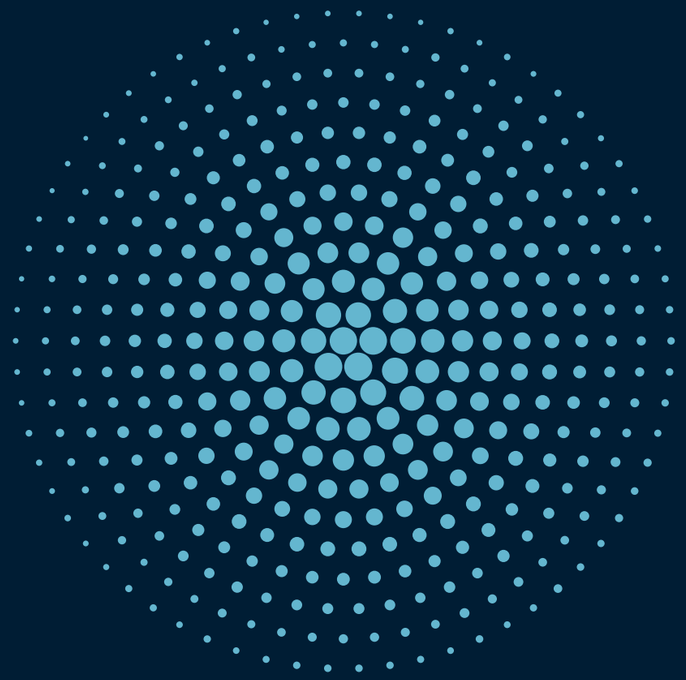

Open source is present everywhere. All around the world, companies and public services are using the open source collaborative methods to innovate and build new solutions. It powers the cloud and provides professional tools for big data and for information and knowledge management. It is in supercomputers, blockchain, the internet of things and artificial intelligence. It is in the internet. It is in our phones and our TVs. It provides us with streaming media. It is in our cars. It runs Europe's air traffic control. The chances are that, in any new project involving software, from kitchen appliances, through web-based public services to highly specialised industrial tools, most of the code will be based on open source.

– European Commission Open Source Strategy 2020-2023

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Foreword

Foreword by Technology Ireland

Technology Ireland is the representative body for the technology sector in Ireland and is the authoritative voice driving effective change for the sector. Our vision is to make Ireland a global technology powerhouse. Together with Skillnet Ireland, we are delighted to see this study on open source and InnerSource Skills in Ireland.

The European Commission's Open Source Strategy 2020-2023, sets out a vision for encouraging and leveraging the transformative, innovative and collaborative power of open source, its principles and development practices. It promotes the sharing and reuse of software solutions, knowledge and expertise, to deliver better European services that benefit society and lower costs to that society. It is an important contribution to the Digital Europe programme. With our thriving innovation ecosystem, Ireland is well positioned to play a key role in bringing this strategy to life.

The collaborative nature of the digital technology sector is very inspiring and a real differentiator of the sector. Open source and InnerSource provide opportunities for even more seamless collaboration and innovation within and between organisations in the tech sector. We look forward to seeing Ireland emerge as a key talent hub for the global open source and InnerSource ecosystems.

Una Fitzpatrick,
Director of Technology Ireland

Foreword by OpenForum Europe

We ask our workforce to leverage cloud, Artificial Intelligence (AI) and large data systems across the sectors of the economy. Open source skills—not only in terms of writing code, but also managing communities and software project management—matter more than skills that are specific and limited to a certain technology.

This does not only matter for the labour force itself. For a country or region, the benefit of an economy's workforce that can realise value from open source is not only reduced monetary costs, increased competition, and more flexible systems, but economic growth. More open source code leads to more jobs, and today's digital jobs require open source skills.

There is a lot of momentum behind open source software in Europe, in industry as well as in politics. It is great to see this study coming out of Ireland examining the skills required by the ecosystem to deliver the promises of this innovation model at scale.

I look forward to seeing how Ireland responds to this report, as it will matter for all of Europe.

Astor Nummelin Carlberg,
CEO of OpenForum Europe

Executive Summary

Open source has been reported to accelerate innovation, improve code quality, and increase efficiencies within organisations. It is recognised as being central to all future technological advancements. InnerSource, which seeks to leverage open source principles and create communities behind a corporate firewall, is linked to removing silos and bottlenecks, improving collaboration and developer productivity.

Open source is now critical for both the private and public sector. 98% of the world's software now contains open source software.[1] The European Commission's Open Source Strategy 2020-2023[2] identified open source software as an enabler for innovation and the Commission also recently released a study[3] showing that open source software and hardware are key for the region's digital transformation and can be a major boost to the region's GDP. Industry reports[4] confirm there is a global shortage of qualified open source and InnerSource talent.

Following a multi-stage study involving a survey and a series of interviews with experts from industry and the public sector in Ireland, we find that there is a broad set of skills required for optimal use and creation of open source software and hardware. Skills required include technical engineering skills as well as non-technical skills such as legal, sales and marketing. Local businesses, international companies based in Ireland, and Irish public sector organisations all report challenges in finding talent locally with the required practical experience to help them deliver their open source and InnerSource priorities.

Investing in developing open source and InnerSource skills would help fulfil the talent needs of Ireland's organisations. Considering the global talent shortage in this space, it would help position Ireland as a leader in the broader open source and InnerSource ecosystem.

This study recommends five specific actions:

1. Curate a directory of existing open source and InnerSource learning resources.
2. Create innovative open source and InnerSource learning Programs.
3. Extend the existing Skillnet portfolio with open source and InnerSource Programs.
4. Support the establishment of Open Source Program Offices (or OSPOs) in educational institutes.
5. Continue the conversation to see how Ireland can become a leader in this space.

Ireland is already home to many local and global IT organisations. To maintain Ireland as an attractive location for organisations focused on digital innovation, now is the time to take action and address the need for open source and InnerSource skills. Focusing on helping organisations identify and develop the open source and InnerSource talent they need in Ireland will help them increase productivity and drive innovation. We conclude that, like our journey with open data, Ireland has the potential to be a leader in the field when it comes to open source and InnerSource. Investment in this area directly aligns with Europe's strategy for a Digital Europe. Moving to act on the points outlined above can help position Ireland as a thought leader and front-runner for the world's open source and InnerSource ecosystems, and a destination for related talent and skills development.

Curate a directory of existing open source and InnerSource learning resources.

Create innovative open source and InnerSource learning Programs.

Extend the existing Skillnet portfolio with open source and InnerSource Programs.

Support the establishment of Open Source programme Offices (or OSPOs) in educational institutes.

Continue the conversation to see how Ireland can become a leader in this space.

Background

Definition of Open Source and InnerSource

Open Source Software

Open Source Software is software that has the following four characteristics:

1. Everyone can run the software, for any purpose.
2. Everyone can study how the software functions and change it so it functions as they wish. Access to the source code is a precondition for this.
3. Everyone can redistribute copies of open source software.
4. Everyone can distribute copies of their modified versions to others.

More details can be found in the Open Source Initiative's Open Source Definition.[5]

Open Source Hardware

Open Source Hardware (OSH) is defined as: **"a growing movement in the personal fabrication community. If an inventor chooses to open source her hardware design, she makes publicly available all the schematics, detailed description of needed parts and software, drawings and 'board' files – basically all the information anybody would need to identically re-create the product or object.[6]"**

To fully qualify as 'open hardware':

1. The interface to the hardware must be explicitly made public, so the hardware can be used freely.
2. The design of the hardware must be made public, so that others can implement it and learn from it.
3. The tools used to create the design should be free, so that others can develop and improve the design.[7]

Open Source Practices

Most in the open source community are careful to clarify that a broader definition of open source exists.The term can also be used to refer to the methods and practices employed by open source developers, namely collaborative, asynchronous, distributed development.

Open source can be both a noun (the code) and a verb. To successfully "open source" your code, it is not enough to just make it available under an open source license and publish it – the most successful projects involve significant efforts in community development to ensure the project's sustainability.

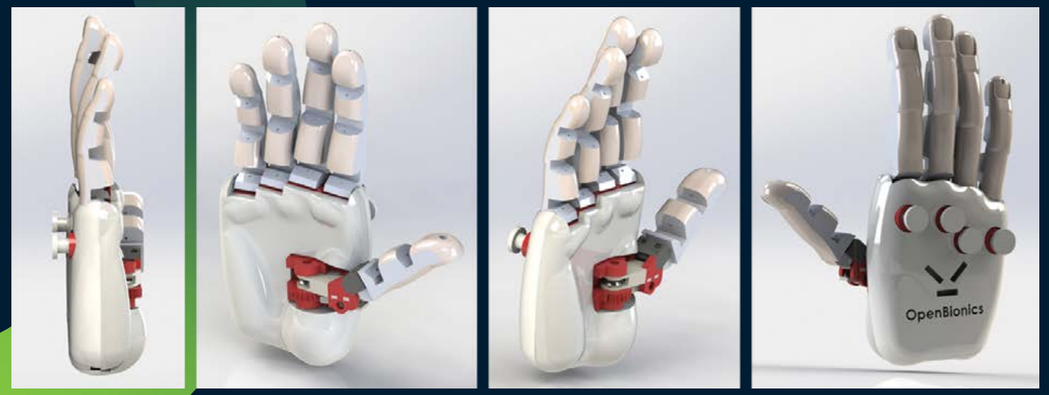
InnerSource

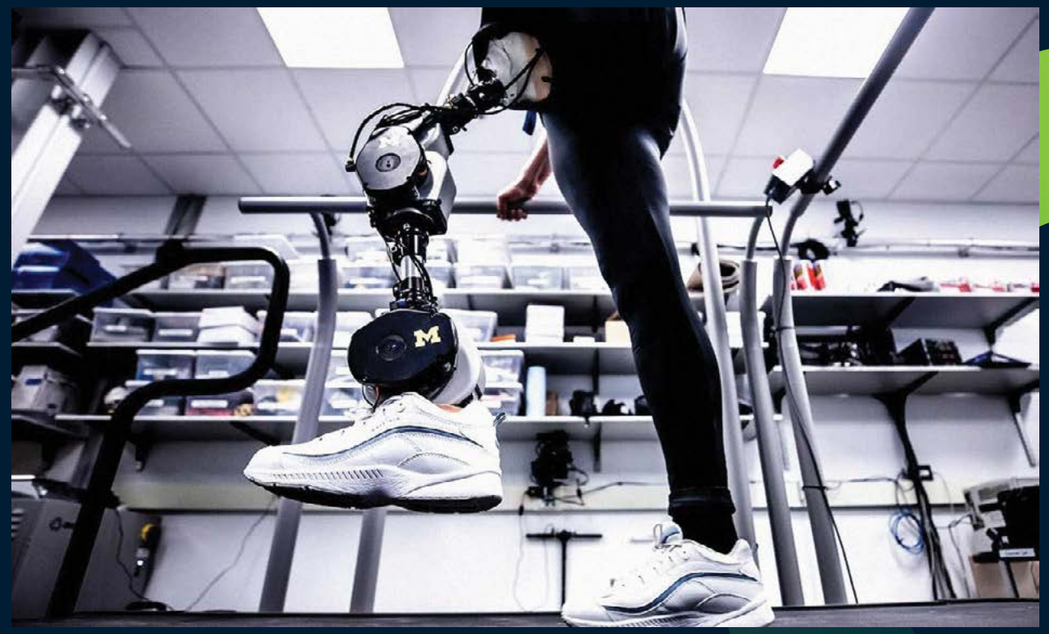
According to the InnerSource Commons,[8] **InnerSource** is the use of open source methods and best practices for software development of proprietary code. Principles of InnerSource development include:

- **Openness:** Anyone within an organisation should be able to find and participate in a project of interest and get involved easily.
- **Transparency:** Anyone should be able to see the project direction, feature requirements, and decision making processes.
- **Prioritised Mentorship:** Anyone wishing to contribute code is upleveled through mentorship so that they understand enough about the host team's project to change it successfully.
- **Voluntary Contribution:** contributions of any kind are voluntarily donated and accepted. This opt-in nature means that each contributor needs to be certain that their involvement adds value to the others' objectives.

Figure 1 (opposite above). Bio-inspired compliant robot fingers from openbionics.org open source initiative

Figure 2 (opposite below). Open Source, artificially intelligent prosthetic leg from the University of Michigan Robotics Department





Open Source is Everywhere

A common misconception is that open source software (OSS) is only created by hobbyists or passionate individuals. This view is long outdated.[9] It is interesting to see the rise of commercial and enterprise open source software over the past decade.

In a 2011 article in the Wall Street Journal, Marc Andreessen, co-founder of Netscape, one of the first browser companies, shared the now-famous saying "Software is eating the world." In Red Hat's 2022 State of Enterprise Open Source[10] report, the authors opined: "Software may be eating the world. But, increasingly, it is enterprise open source software that is doing most of the chewing."

98% of the world's software contains open source code.[11] 96% of the world's top 1 million servers run on open source software,[12] and 90% of all cloud infrastructure runs on open source software. The 2022 State of Open Source Report[13] from OpenLogic by Perforce and the Open Source Initiative (OSI), showed that 76% of respondents increased the use of open source software in the past year. Red Hat's 2022 State of Enterprise Open Source[14] report put the figure at 80%.

The use of adoption of open source is nearly ubiquitous, but contributions back to the open source ecosystem are also growing. Red Hat's 2022 State of Enterprise Open Source[10] report stated that 82% of IT Leaders are more likely to select a vendor who contributes to the open source community.

Code quality and improved developer practices are also associated[15] with open source development. A McKinsey report[16] measuring developer velocity described, the "biggest differentiator" for top-quartile companies in an industry vertical was "open source adoption" where they shifted from being users to being open source contributors.

A 2020 study from O'Reilly Media[17] suggested that developers should be building skills around open source technologies. In that report:

- Open source software (OSS) was rated equal to or better than proprietary software by 94% of respondents.
- When choosing cloud providers, 70% of respondents prefer one based on open source.
- 65% of respondents agree completely that contributions to open source projects impress potential employers and result in better professional opportunities.

A 2022 paper[18] by Rafaella Antoniou et al describes the growth of open source hardware in recent years:

"we have observed a proliferation of open source hardware (OSH) initiatives, with some developing profitable businesses. At the time of writing, the Open Source Hardware Association has certified 1663 OSH projects and the Open Know-How search engine lists 486 OSH projects."

InnerSource is Growing Momentum

InnerSource is a relatively newer movement. Although the term was coined by Tim O'Reilly in 2000[19], it wasn't until 2015 that it emerged into more popular usage when a community of practitioners founded InnerSource Commons with the goal of sharing knowledge around the methodology. InnerSource saw an increase in adoption year on year, and particularly over the years of the COVID-19 pandemic, as a way to facilitate asynchronous collaboration between software development teams that is independent of location. In recent months, InnerSource appeared for the first time on Stack Overflow's 2022 Developer Survey under "Developer Experience: Processes, tools, and Programs within an organisation" with over 16% of respondents reporting that their organisation had an InnerSource program. Since it was founded in 2015, InnerSource Commons has grown to represent over 500 organisations. A small sample of those organisations who have spoken publicly about their use of InnerSource is included opposite.

Figure 3. Motivations for InnerSource.
Source: State of InnerSource 2021[20]

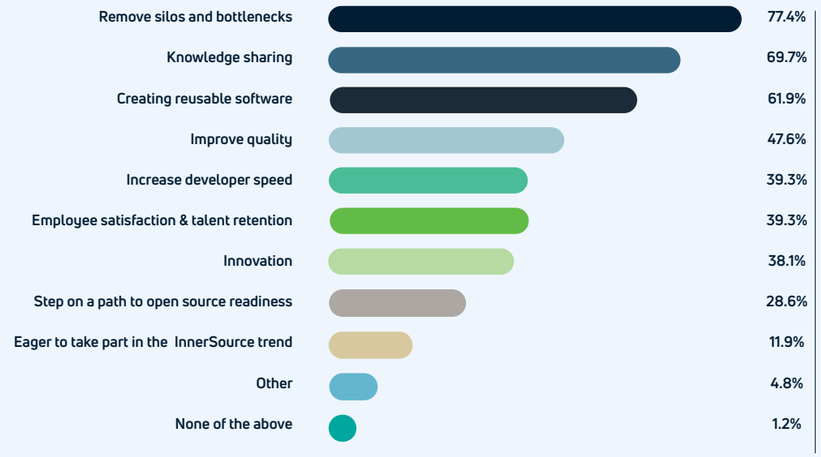


Figure 4. A sample of organisations that have spoken publicly about their use of InnerSource.
Source: www.innersourcecommons.org

Open Source Policy Trends

The European Commission has stated[21] that open source has an important role to play in invigorating the EU's social market economy, promoting competition and encouraging SMEs — our innovators and entrepreneurs.

"The Commission leverages the transformative, innovative, and collaborative power of open source, encouraging the sharing and reuse of software solutions, knowledge and expertise, to deliver better European services that enrich society and focus on lowering costs to that society."
– European Commission

As noted in the Think Open: Strategy for Open Source 2020-2023[22], Open source is close to the essence of public service, because: it is public code, which makes it a good use of public money, one that promotes freedom of choice and avoids getting 'locked in'; it makes it easy to use and reuse software solutions, so we can pool efforts to create valuable cross-border services that are interoperable, and increase efficiency; and it is easy and efficient to add features to open source software, which can be freely shared with anyone, for any purpose. This means that everyone can benefit.

In May 2022, the European Commission released a study called 'The impact of Open Source EU economy.'[23] The report predicts that an increase of 10% in contributions to open source software code would annually generate an additional 0.4% to 0.6% GDP, as well as more than 600 additional ICT start-ups in the EU.

The study showed that the top motivations for being involved in open source were: finding technical solutions, avoiding vendor lock-in, advancing the state of the art of technology, developing high quality code, and seeking and creating knowledge. Other motivations included cost-savings, lowering internal maintenance efforts, access to royalty-free code, and increasing returns on R&D investments. You can see a selection of the recommendations from the report below.

From a global perspective, many non-governmental organisations are embracing open source as a way to accelerate the deployment of digital solutions. The World Health Organization is the first agency of the United Nations to launch a formal Open Source Program Office (or OSPO), to help increase the agency's capacity to use and develop open source solutions to address public health challenges.[24] The Irish government successfully used open source in its response to the COVID

The impact of Open Source on the EU Economy

Knowledge Creation
Increase R&D funding related to OSS (Open Source Software) and OSH (Open Source Hardware) projects through existing programmes like Horizon Europe, and new initiatives aimed at SMEs start-ups, and individual developers; and offer research awards and prizes for OSS and OSH communities, students, and professors.

Entrepreneurial Activities
Provide entrepreneurial skills to OSS and OSH based start-ups with financial support from Open Source Software and Hardware (OSSH) foundations.

Human Capital Development
Promote open source education, - including development, business models, licensing, and management - in higher education institutions; offer certification licenses to individuals with OSSH skills; and support research projects to increase the diversity of contributors.

Regulatory Environment
Promote OSS as a major channel of knowledge and technology transfer; improve the inclusion of OSS in public procurements; consider open source in future revisions of European copyright and patent legislation; and fund security audits of critical OSS projects.

Building Institutional Capacity
Create and fund a network of up to 20 Open Source Project Offices to support and accelerate the consumption, creation, and application of open technologies.

pandemic and is participating in Programs such GovStack[25], a multi-stakeholder initiative led by the United Nation's Digital Impact Alliance, among others.

"In the Irish Government, we are actively engaging with the EU and also with initiatives such as GovStack, because we very much see the potential for open source in Ireland to help us build solutions that can enable pan-societal and pan-European activities such as travel, health and education to be much more simple and convenient. We strongly believe that open source can help with this by assisting better collaboration, stronger security and greater transparency."

We demonstrated this, and learned much at the same time, through our work on the COVID Contact Tracing App and the Digital COVID Certificate and we are rapidly beginning to understand how those learnings can help us build better user experiences through Key Life Events, Digital Wallets and Digital Credentials. This is a very exciting time for not only Digital Government, but also open source, innovation, and our burgeoning talent at individual, start-up and SME level. We hope to use and foster all of these to build on Ireland's reputation as a progressive Digital Nation to live and work in." – Barry Lowry, Irish Government CIO, Department of Public Expenditure and Reform.

There is also an emerging discussion of how open source software forms a critical part of any open science strategy. In an April 2022 publication by the US National Academies of Sciences, Engineering and Medicine on Open Scholarship Priorities and Next Steps[26], discussed how from a reproducibility standpoint, the sharing of code and software are critical for open science.

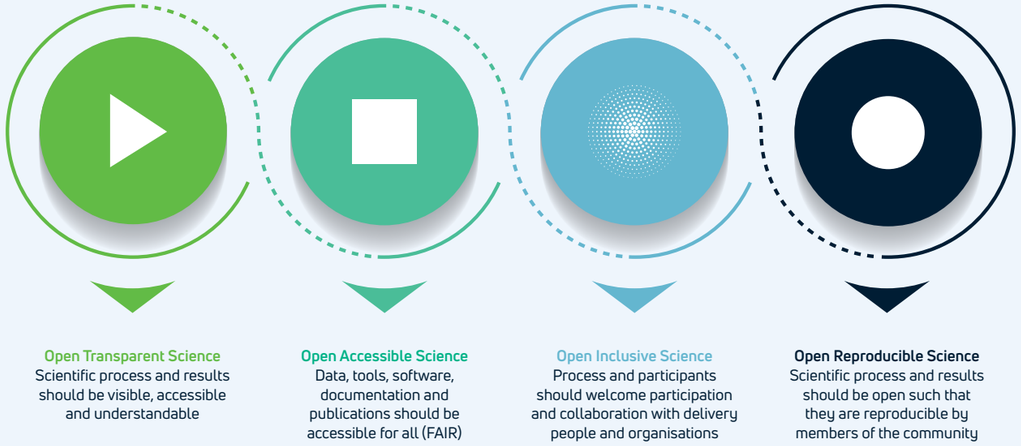


Figure 5. The "open" aspects of open source science.
Source: Steven Crawford, US National Academies of Sciences, Engineering and Medicine workshop presentation, Dec 2021

Open Source & Open Data

The concepts of open source and open data are often linked, for example both are listed as key principles of Open Science or Open Scholarship . Open data has been a key strategy for the Irish government since the launch of Ireland's Open Data Initiative in 2014, when we joined the international Open Government partnership. Successful implementation of the subsequent national strategies (e.g Open Data Strategy 2017-2022) has ensured that Ireland moved from mid-table to 2nd place in the EU Data Maturity assessment in 2021. There is much the open source movement in Ireland can learn from the open data community's journey. Not only is there much that can be leveraged from related strategic implementation plans, but also from the individuals involved, many of whom share an interest in all things open.

Open Source and InnerSource Skills Gap

There remains a shortage of qualified open source talent. In January 2022 the Linux Foundation released the 10th Annual Open Source Jobs Report.[27] The vast majority of employers (93%) report difficulty finding sufficient talent with open source skills. This trend is not going away with nearly half (46%) of employers planning to increase their open source hiring in the next six months, and 73% of open source professionals stating it would be easy to find a new role should they choose to move on.

The 2022 State of Open Source Report[28] from Perforce and the Open Source Initiative listed "lack of internal skills to test, use and integrate" open source as the top reservation in adopting open source. In Red Hat's State of Enterprise Open Source Report 2022,[29] one of the top barriers to adopting enterprise open source was also lack of internal skills to manage and support enterprise open source (32%).

These global industry reports align with feedback from the UK. The State of Open UK 2022[30] report includes references to the open source skills gap with three of the top five open source challenges for organisations including lack of coding technical knowledge (22%), lack of licensing, governance and good practice knowledge (21%), and lack of understanding of open source in senior management (21%).

Lack of open source skills and development resources often overlap with the most popular technology trends, which were also referenced in the State of Enterprise Open Source Report 2022. IT infrastructure modernisation often relies on open source projects like Kubernetes[31] , a popular technology associated with containerisation.[32] 70% of IT leaders who responded to the survey work for organisations that use Kubernetes. When asked about what the biggest barrier to adopting Kubernetes, the top obstacles were not having the necessary skills for adoption (43%) and not having the development staff or resources (39%). Similarly, in the 2022 State of Open Source Security Report,[33] it is noted that many software developers have not been trained on how to develop secure open source software. When asked how organisations could improve the security of developing open source software, the third ranked improvement is to provide more training in secure and memory safe programming, identified by 53% of respondents.

As an emerging software development methodology, there is a scarcity of research quantifying the global skills gap for InnerSource. However, the latest State of InnerSource 2021 report highlights that the third ranked blocker to InnerSource success is lack of familiarity with InnerSource principles. The report identifies a need to educate organisations about what is needed to set up successful InnerSource projects.

10th Annual Open Source Jobs Report

93%	of hiring managers report difficulty finding professionals with the needed open source experience	90%	of hiring managers are willing to pay for certifications
86%	of hiring managers say hiring open source talent is a priority for 2022	78%	of hiring managers are hiring the same or more open source professionals compared to 2021
77%	of organisations are growing their use of cloud/container technologies	76%	of professionals work on open source projects related to Linux
73%	of open source professionals believe it would be easy to find a new position	67%	of hiring managers seek open source professionals with architectural skills
69%	of hiring managers are more likely to hire certified open source professionals	62%	of organisations employing open source professionals encourage diversity in hiring
58%	of hiring managers have given higher salary increases to retain open source talent	48%	of open source professionals and hiring managers rate their employee diversity efforts as good or excellent

Figure 6. Linux Foundation 10th Annual Open Source Jobs Report

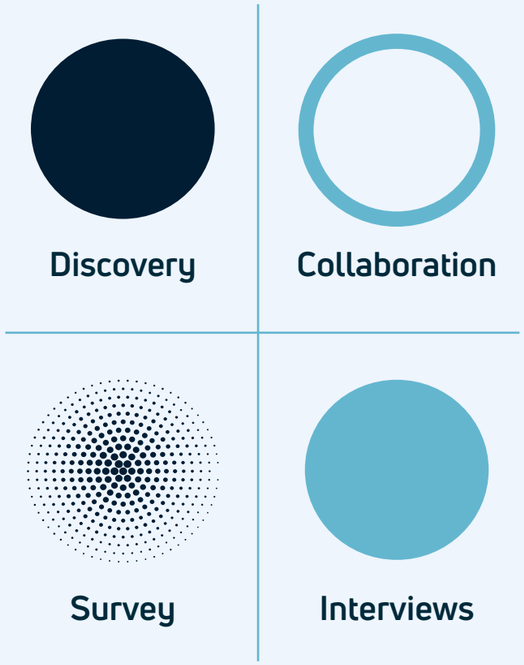
Methodology

Research Goals

We embarked on this project to understand the skills requirements related to open source software and InnerSource adoption in Ireland. The project focused specifically on the following goals:

- Identify organisations in Ireland who are dependent on or have the potential to leverage open source software and InnerSource to meet their organisational goals.
- Identify their related skills needs.
- Recommend next steps that might be taken to address skills needs.

We conducted this study in four stages as detailed below.



Stage 1: Discovery

In the discovery stage, we reviewed a selection of papers and reports covering the skills needs and analysis in the open source and InnerSource ecosystem. This provided a baseline on how corporate interest in open source and InnerSource has grown and evolved, and also served as a basis to prepare the following stages of the project. The discovery stage also confirmed that little research exists on skills requirements related to open source and InnerSource in Ireland.

Stage 2: Collaboration

In the collaboration stage, we conducted two virtual workshops involving a total of 18 local industry representatives recruited from the Open Ireland Network. We made a specific effort to include representatives from a diverse set of organisations in terms of size, domain, and origin (Irish or International headquarters).

The goals of the two workshops were to introduce the research plan, elicit feedback on the scope and research strategy of the research project, and get input on how to successfully promote the research project. One of the data collection instruments was a survey, and the workshops offered an opportunity to recruit volunteers to pilot this survey and get feedback on the range of questions.

Stage 3: Survey

In Stage 3, we consolidated the input and feedback elicited from stages 1 and 2 to design a survey. All workshop participants reviewed the survey which we then refined. We set up the survey using SurveyMonkey. The survey was live for just over three months; we advertised it through a number of channels, including via social media and through the professional networks of the workshop participants. It was also advertised in a range of open source and technical groups within Ireland, including Open Ireland Network, Technology Ireland ICT Skillnet, Irish Tech Community and Scale Ireland. We collected a total of 89 responses; we removed three responses which were obvious duplicates. As none of the questions were compulsory, there was some variety in the number of responses per question.

Stage 4: Interviews

In Stage 4 we sought to investigate the findings from the survey in Stage 3 in more detail. All respondents of the survey were invited to participate in an interview study to explore the themes of the survey in more detail. Of those that responded positively, we selected 18 interviewees. Interviewees were selected to maximise diversity across domains, organisation size, and to achieve a good mix of indigenous and international organisations. Organisations were categorised as small (<50 employees), medium-sized (50-249 employees), and large (>250 employees). Table 1 lists the 18 interviewees.

Individual	Organisation	Org Size	Org Domain	Org Type
Danese Cooper Founder and Chair, InnerSource Commons	**InnerSource Commons** is a global non-profit dedicated to creating and sharing knowledge about InnerSource.	Small	Technology	Global Non-profit
Anluan Dunne Key Account Manager for Enterprise, Red Hat Ireland	**Red Hat** is an American IBM subsidiary software company that provides open source software products to enterprises.	Large	Technology	Global Corporate
Brian Farrell CEO, Founder & Managing Director, Securelinx	**Securelinx** is an Irish company that provides Linux based infrastructure solutions such as subscriptions, services, support and training to customers throughout Ireland and the UK.	Small	Technology	Irish Corporate
Luke Feeney Co-founder, TerminusX	**TerminusX** is an Irish spin-out from TCD providing open source graph database that is focused on collaboration and versioning.	Small	Technology	Irish Corporate
Michelle Kearns Head of IT, Boots Ireland	**Boots Ireland** is an international pharmacy-led health and beauty retailer with 89 Boots Ireland stores and just over 2,000 employees in Ireland.	Large	Retail Healthcare	Global Corporate
John Looney Software Engineering Manager, Reddit	**Reddit** is an American social news aggregation, content rating, and discussion website. Registered users submit content to the site such as links, text posts, images, and videos, which are then voted up or down by other members.	Large	Media	Global Corporate
Fiona Manning Open Source Program Manager, VMware	**VMware** is an American cloud computing and virtualisation technology company.	Large	Technology	Irish Corporate
Barry McGinley Senior Systems Engineer, EPS Global	**EPS Global** was established in Ireland in 1999 and is a leading franchised distributor for specialised IT components and semiconductors used in data networking and storage, virtualisation, cloud, and the Internet of Things.	Medium	Technology	Irish Corporate
Ger McMahon Head of ALM Tools and Platforms, Fidelity Investments	**Fidelity Investments** is an American multinational financial services corporation.	Large	Financial Services	Global Corporate
Lorraine Morgan Senior Lecturer, University of Galway	**University of Galway** is a public research university located in the city of Galway, Ireland.	Large	Education	Irish University
Pat Mulchrone Head of DG Base at Product Development Unit OSS, Ericsson	**Ericsson** is a Swedish multinational networking and telecommunications company.	Large	Technology	Global Corporate
Joan Mulvihill Digitalisation and Sustainability Lead, Siemens Ireland	**Siemens** is a German multinational conglomerate corporation and the largest industrial manufacturing company in Europe.	Large	Manufacturing	Global Corporate
Cian O'Maidin Founder and President, NearForm	**NearForm** is an Irish company that design and build future-ready digital products to accelerate transformation and create digital capability.	Medium	Technology	Irish Corporate
Adrian O'Sullivan Director of Open Source Ecosystems, Huawei	**Huawei** is a Chinese multinational technology corporation. It designs, develops and sells telecommunications equipment, consumer electronics and various smart devices.	Large	Technology	Global Corporate
Stella Power Founder and Managing Director, Annertech	**Annertech** is an innovative open source digital agency in Ireland that builds and maintains website and web applications.	Small	Technology	Irish Corporate
Tony Shannon Head of Digital Services, Office of the Government CIO	**Office of the Gov CIO (OGCIO)** sits in the Irish Department of Public Expenditure and Reform and has the leadership role for the digital agenda across Government.	Small	Government	Irish Public Sector
Mihai Todor Principal Software Engineer, Optum	**Optum** is an American pharmacy benefit manager and health care provider. It is a subsidiary of UnitedHealth Group.	Large	Technology	Global Corporate
John Whelan ICT Research Commercialisation Manager, Trinity College Dublin	**Trinity College Dublin** is Ireland's highest ranked university.	Large	Education	Irish University

Table 1. Respondents featured in the in-depth interviews

Research Findings

Organisation Interest and Investment

97% ENGAGED IN OPEN SOURCE & INNERSOURCE

- Using open source tools
- Integrating open source components into products & services
- Facilitating Research & Development

44% COLLABORATING WITH OPEN SOURCE COMMUNITIES

49% USING OPEN SOURCE TOOLS & PRACTICES

When asked about their main area of interest in this survey, half of the respondents replied that their primary interest area was open source software and 21% responded that their interest was in InnerSource. A smaller number of respondents (9%) indicated a primary interest in Open Source Hardware.

Open Source - Gaining Momentum

We explored which open source and InnerSource activities each organisation engages in (see Figure 7 for full details). The vast majority of respondents (97%) indicated that they engaged with open source or InnerSource one way or another. Some of the most popular activity areas noted for respondents' organisations were:

Adopting Open Source

- Most respondents (63%) reported using or deploying open source software or hardware.
- 52% innovated on top of open source by integrating open source software or hardware in products or services.
- Using open source to facilitate research and development (40%).

Creating and Engaging with Open Source Communities

- Collaborating with individuals in open source projects or foundations (44%).
- 28% of respondents indicated that their organisations are currently involved in creating open source projects and building developer communities around them.

Open Source Tools and Practices

- Using tools and practices associated with open source ecosystems (49%), for example GitHub and InnerSource
- Creating InnerSource initiatives, to support the use of open source practices within organisations.

5 reasons to use Open Source & InnerSource

- Faster Time to Market
- Reduced Cost
- More Innovation
- Grow Skills
- Access Talent

It is clear that organisations adopt and engage with open source and InnerSource in a variety of ways. Interviews with the selected experts provided further insight into the various reasons for using open source.

1. Faster time to market, reduced cost, and more innovation

Many organisations today rely on open source software components that are integrated into technology solutions. The use of high-quality and reliable OSS products enables organisations to deliver faster: established OSS products don't have to be developed allowing organisations to shorten the time-to-market. Fiona Manning, Open Source Program Manager at VMware, explained that:

"Open source is essential to VMware's technology solutions, and essential to multi-cloud solutions. 100% of our products contain open source. [...]. Time to market is faster, and from that, there's a cost-benefit: as we can reuse software, it takes us less time to deliver the end product, and we can pass those savings on to our customers."

Joan Mulvihill, Digitalisation and Sustainability Lead with Siemens Ireland also shared how open source speeds development and improves quality. She also connects Siemen's InnerSource practice to their ability to practice open source:

"Open source has been a large part of the Siemens embedded story, and we want to give back. Using and contributing to open source projects help us provide more reliable products and develop faster. We also focus on driving an InnerSource culture at Siemens to help us become better open source citizens."

Open source has long been associated with innovation, as there is a much shorter and direct feedback loop between users and developers.

"There's more innovation with open source because you have that direct feedback loop." – Anluan Dunne, Red Hat

2. Open Source lifts all boats

OSS is like the rising tide that lifts all boats. The use of OSS allows organisations to focus on value-adding, differentiating software, rather than wasting expensive resources to build 'commodity' components.[34] Rather than building your own database system or operating system, it is far more practical to spend resources on differentiating features that add value to customers. Different organisations, who might be competing on the value-add that they offer their customers, all benefit from a common foundation, reducing wasted efforts. John Looney, Software Engineering Manager at Reddit, commented:

"We benefit from enhancements other companies add to those projects, and the maintenance burden is shared, not duplicated. It makes no sense for every company to work on their own infrastructure automation software when we can share components, expertise, and experience.[...] In some industries, being able to harness open source will be the difference between them being able to grow and them being a really valuable company and them being swamped by technical debt and software that doesn't do the job they need. I would absolutely say it's a big growth area."

Others also recognised the value of OSS communities and the expertise that these communities contain. Michelle Kearns, Head of IT at Boots Ireland, commented:

"It makes things simpler and it definitely reduces friction. Because people are trying to achieve a goal together as opposed to being in competition with each other. People want to try and solve each other's problems and help each other. I think it's definitely something that we need to harness."

Organisations can tap into that pool of expertise that exists in open source communities, but there is also a recognition that it is important to contribute back, to ensure that open source communities are sustainable and can thrive. Ger McMahon of Fidelity Investments remarked:

"There's a huge amount of expertise in the community, so you're able to tap into that, versus being a novice in that piece of technology. So there's a huge amount of benefit. But you have to give as well in order to ultimately maximise the benefit."

3. Attracts talent and grows skills

Recruitment is a hugely important issue for software organisations; software developers are highly sought-after knowledge workers, and it is common that developers change jobs every few years. Attracting and retaining talented software developers is very important, because they embody the software development capacity of an organisation. Software developers today expect that organisations are aware of and engage with open source software. It is also common today that some developers pursue a career as an open source developer: paid by an organisation, but hired to work on specific open source software. Organisations who shy away from open source will thus have far more difficulty in attracting and retaining software developers. Ger McMahon of Fidelity Investments commented as follows:

"At Fidelity we want to move more to being participants in the open source community, not just consumers. ... It helps to build capabilities quicker. It allows you to grow, and then it allows you to attract talent – that's another big thing. It attracts talent, so it allows you to scale, grow capabilities, quicker."

4. Thought Leadership

Open source has moved from a technical niche to mainstream. Organisations that ignore open source will have difficulty attracting IT talent in the future. Open source software and InnerSource, which codifies the "open source way[35]" to developing software represents the future, and organisations that can leverage and harness these skills will thrive.

"More people should know something about open source, because what was quite a niche technical area, is now becoming much more mainstream and impacting all our lives. I think it's important to understand its potential and also see it as both a learning and a transformation resource. If you want to understand technology in 2022, you should turn to open source methods, skills, and tools because that's generally where the thought leadership and the best learning in digital change is now to be found. " – Tony Shannon, Office of the Government CIO

The Rise of Professional Open Source Organisations & Roles

About a quarter of the respondents considered their organisations to be Commercial Open Source Software companies, either building products or Software-as-a-Service (SaaS) offerings on top of open source projects, or offering professional products or services for open source or InnerSource development (26%).

Interestingly, only 12% reported that they engage with open source or InnerSource in a personal capacity only. This aligns with global trends that show many of today's software developers are engaging with open source in a professional capacity.[36] Perhaps the best known example of this is the Linux kernel, where 80% of contributions are made by organisations, rather than individuals. In terms of formal Programs or investments, 54% of respondents indicated that their organisation had formal policies governing the use and contribution to open source projects. 52% reported to have education or awareness Programs around open source or InnerSource, and 38% of respondents indicated their organisation has an open source program office.

What activities does your organisation engage in related to open source or InnerSource?

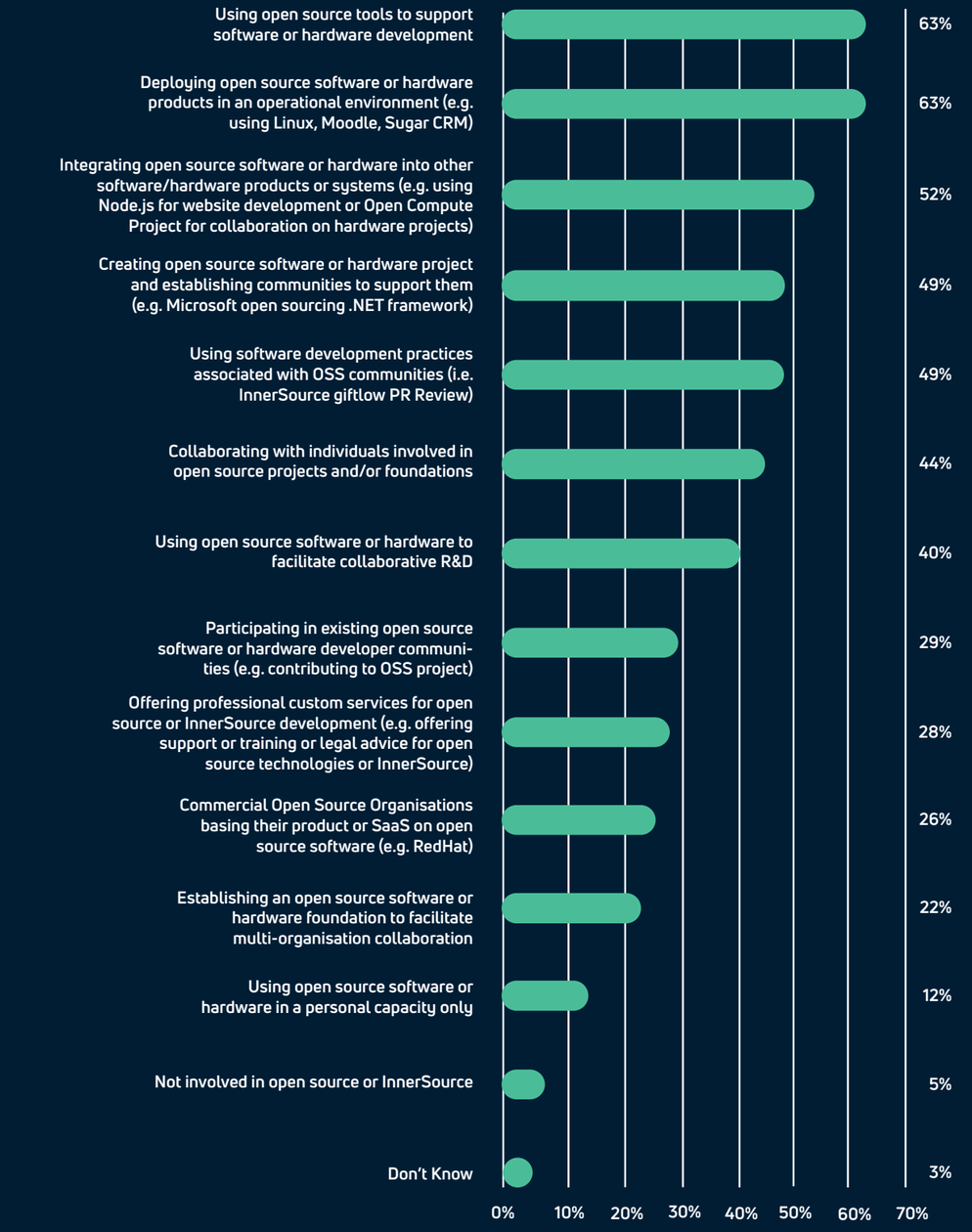


Figure 7. Open source and InnerSource activities

Engineering Skills

TOP ENGINEERING SKILLS REQUIRED IN NEXT 3 YEARS

- Developing software & hardware with open source tools
- Deploying open source software & hardware
- Collaborative coding skills
- Integrating open source software & hardware into programs & systems
- Open source development practices & InnerSource

We asked respondents how often open source and InnerSource skills have been required for their staff in the past three years, and in the upcoming three years. Figures 8-11 reflect the skills expected to be required in the next three years (selected as "often" and "very often") and the growth from the skills expected in the past three years. For example, "Using collaborative coding skills (77%, growth of +19%)" means that 77% of respondents expect "Using collaborative coding skills" to appear as a requirement, either often or very often, for technical roles in the next three years. That is an increase of 19% in how often or very often that skills were expected in the past three years.

The most pressing areas where skills are required are related to the use of open source tools to support software or hardware development (79%) and the deployment of open source products (79%). Other important areas reflected the maturing of the use of open source with organisations:

- Incorporation of open source components in modern software architecture (67%, growth of +7%)

- Security aspects of open source software or hardware (65%, growth of +21%).

The interview findings suggested that the benefits of open source as part of an engineering solution aren't fully appreciated, and that the focus in Ireland is too much on purchasing of commercial off-the-shelf solutions, suggesting a lack of awareness of the potential of open source.

"When it comes to the Irish market, there is very little appreciation of the benefits of open source. People think 'I have a problem; I will purchase a solution.' They don't think 'I have a problem; how do I best engineer a solution?'" – Anluan Dunne, Red Hat

Many of the interviewees commented on their inability to find qualified technical staff in Ireland. Adrian O'Sullivan of Huawei commented on this issue as follows:

"[When] we look for new staff, we recruit from all across Europe. There is some experienced talent here, but we perhaps don't get as many applications as from other European countries."

Stella Power, founder and managing director of Annertech, shared the challenges faced by rapidly growing small and medium enterprises focusing on open source technology, Drupal:

"There's a huge gap in terms of Drupal development skills. We're continually growing, and I'm always hiring but I just can't find the people in Ireland. "

IT organisations today set high requirements for professional software developers, who are expected to have expertise on enterprise-grade quality, security, reliability and agility, and interviewees indicated that awareness and expertise of these issues is lacking in today's graduates. Anluan Dunne, Account Manager for Enterprise at Red Hat Ireland commented that these topics are insufficiently discussed and taught in Ireland:

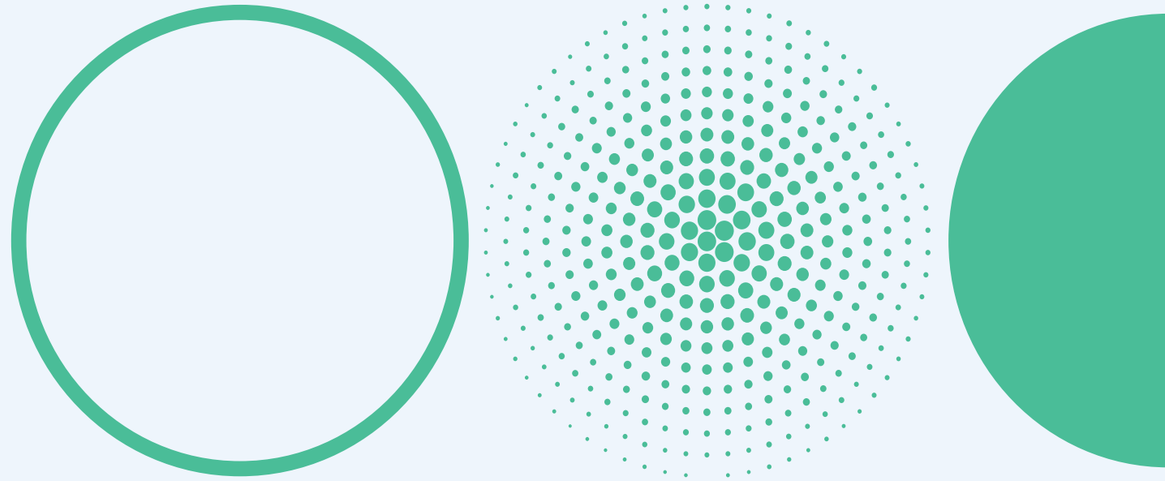
"We're also not talking at all about the security implications of running open source projects. How do you guarantee that the open source project that you forked or you're using is not malicious?...We're not teaching people about that enough."

Many software development support tools today are open source, such as continuous integration and deployment tools and frameworks, as well as the Kubernetes application container management system. Detailed knowledge of setting up and running such systems is typically not taught at the undergraduate level, and this is expertise that companies are looking for, as several study participants described:

"Having a good CI/CD process is necessary to enable open source, ensuring you always have the latest version of technology." – Pat Mulchrone, Ericsson

"All of our financial services industry customers cannot source people with sufficient Kubernetes experience right now – they're not available in the marketplace." – Anluan Dunne, Red Hat

Many of these skills relate to a greater, up-to-date understanding of the current and emerging landscape. Barry McGinley, Senior Systems Engineer at EPS Global, described how they needed to know what open source hardware to bet on, in a rapidly changing environment. In fact, Open Hardware was called out as an emerging area of rapid change by multiple interviewees.



"There's many different types of roles – documentation writers, for example – and there's open source hardware as well. RISC-V is taking off, so there's a whole new wave of open source coming." – Adrian O'Sullivan, Huawei

A significant number of survey respondents suggested there will be a requirement to participate in open source software or hardware developer communities (70%). This represented the largest area of growth (+23%) between skills required today and in the future. Another large increase in the coming years can be noted for those who are planning to require skills relating to creating open source software or hardware projects and establish communities to support them (47%, growth of +18%). In addition, perhaps as a result of the expected increase in need for skills related to building and contributing to open source, some of the respondents explicitly called out the need for more experience in code contributions to the open source ecosystem. The interviews featured similar themes. One important topic is a general awareness of when and how to make changes to open source components when such changes are needed by companies. Organisations that need to modify open source components can of course do so, but ideally those changes are contributed back to the project. In some cases the modifications are highly tailored to the organisation, and while the open source license requires that these changes are made available as open source as well, that does not mean they will, or should be accepted into the main repository. In other cases modifications are more general, and in such cases it may be preferable to integrate those upstream, which would also reduce the future maintenance effort on those custom changes. John Looney of Reddit explained the need for people that have the ability to understand this and make the appropriate trade-off:

"We need people who can assess when it makes sense to make local customisations or upstream those changes to the community. In some open source projects, the code quality may be even higher than in the enterprise, and the effort required to get changes accepted to a project can be significant. However, taking the time to upstream changes does reduce your technical debt in the long term, and can build credibility in a shared community of peers. We need people who understand those two trade-offs and know when to make the right call on this."

Any contributions to an open source project must achieve the minimum quality bar set by that project. Ensuring that code contributions "fit" and follow the guidelines and standards that are set by the open source project are key to getting such contributions accepted. These skills can be hard to find, as Ger McMahon of Fidelity Investments observes:

"I don't believe those skills are in the Irish market today. Open source has a much higher bar, in terms of the quality of the commit, the amount of testing and various things that need to happen on document to verify that it is a really high quality."

Technology Skills

In terms of concrete and practical engineering skills, we also asked respondents to list which projects or technologies they believed would see skills gaps in the next three years. Nearly 100 separate projects were listed (see Table 2), which demonstrates the wide breadth of open source technologies and projects Irish organisations rely on. Included opposite is a list to give a sample of the projects and technologies mentioned

Kubernetes was mentioned most often, indicating that container management is a key technology in industry today. Other key terms are machine learning, blockchain, and digital credentials/ wallets, all emergent technologies and techniques. Other technologies are more established, such as Linux, Git, and Node, and yet their appearance in this list suggests that these 'basics' remain important for the software industry today in Ireland.

3Scale	FEniCS	Oniro
Airflow (or similar)	Git	OPA
Alfresco	Go	Open / Explainable ML
AMQ	Golang	OpenEuler
Ansible	Hadoop	Open Source DBs
Any open hardware project	Iceberg	OpenShift
Apache BigData	Information Mediator	Postgres
Apache Flink	IoT projects	Prolog
Apache Spark	Istio	Python
Api security technologies	Jaeger	Quantum Computing Projects
Automation	Jenkins	RDS
Automotive Grade Linux	Kafka	React
Bioinformatics tools	Knative	Real-time tech
BlackDuck	Kotlin	Red Hat
Blockchain projects	KubeEdge	redshift
Camel	Kubernetes	Rust
CNCF related projects	Licensing	Storm
Digital Credentials	Linux	Sugar CRM
Digital Wallets	Low Level IaaS projects	Telecom Infra Project
Docker	Mflow	Tensorflow
Edge Computing	Machine Learning projects	TerminusDB
Elastic	Machine Learning ops	Terraform
Embedded linux	MongoDB	TypeScript
Erika3	MySQL	Wagtail (django)
	Node.js	

Table 2. Sample open source projects of interest

Collaboration Skills

While creating open source software requires very rigorous technical skills, collaboration skills are equally important. The survey suggested an increasing need for training in several of these skills that are key to collaboration:

- Using collaborative coding skills (77%, growth +19%).
- Creating documentation collaboratively (68%, growth +23%)
- Using software development practices associated with open source communities or InnerSource (72%, growth of +19%).

Luke Feeney, co-founder of TerminusX, summarised the need for these collaboration skills as follows:

"It's also very hard to find people who are really good technical writers, people who are good at organising and bringing people together into a community. Those things are not easy at all. And if people haven't done it before, which is often the case in Ireland because we have a very small open source group, then it's definitely harder."

Technical writing is one of these collaboration skills that was highlighted. Software is not only about the code, it is also about sharing mental models and explaining the design and usage of systems to others. Feeney elaborated on this point, highlighting the need to train people with this skill:

"Good technical writing, well-structured, educational, is a huge enabler of growth for companies like ours, and trying to find those skills and the willingness to do it is hard. If we could have more formal development of those types of skills [...] it would be a huge help.

Other collaboration skills include organisation, coordination, and conflict resolution also emerged as being very important. There is a very strong recognition that for any organisation to succeed and grow, there is a need for people who can manage and organise a community:

"Community organisation skills are also really important, and it's something that we don't really teach. If we're going to be successful, our community is the thing that will really enable us to grow and to reach more people." – Luke Feeney, TerminusX

"In terms of soft skills, you need to learn about the structure of how to collaborate. In open source, you can't just allow every single thing in without some kind of a peer review. And then when people disagree, how do you resolve those conflicts?" – Adrian O'Sullivan, Huawei

"It would also be great if there were opportunities for people to learn in a welcoming manner, how to deal with open source communities. It can be low-stakes collaboration, and those kinds of skills early on would be a huge boon." – John Looney, Reddit

Non-Engineering Skills

TOP NON-ENGINEERING SKILLS REQUIRED IN NEXT 3 YEARS

- Licensing & Compliance
- Open Source Business & IP
- Open Source Policies & Procedures
- Sales & Marketing
- Ethics, Social & Sustainability Skills

A primary and recurring theme throughout this study was an urgent need to focus on more than just the technical aspects when it comes to leveraging open source's full potential for Ireland. The following supporting functions are all now necessary for organisations who are professionalising their use of open source and InnerSource. Many of these areas have little or no formal education resources readily available. These include:

- Open source licensing and compliance expertise (58%).
- Understanding how and why to leverage open source in your business (58%) and technology transfer and innovation model expertise (51%).
- Open source policies and procedures e.g. for procurement (51%)
- Sales and marketing skills for open source ecosystem (33%).
- Ethics, social, sustainability issues related to open source (35%).
- HR / recruitment skills for open source ecosystem (33%).
- Open Source Program Management (28%).
- Open Source Community Management (23%).

John Looney has years of experience working in engineering in organisations such as Google, Intercom and Meta (previously known as Facebook). He is currently an Engineering Manager at Reddit. He shared his point of view on the importance of these non-engineering skills:

"Legal, accounting, and infosec [information security] are probably the three big non-engineering disciplines that need help with understanding open source."

Further, Looney emphasised the need for training on Open Source Program Management, and the lack of available courses on this:

"Another thing we probably need is a few months of a short course in Open Source Program Management (OSPM). A lot of big companies will have an open source program management job. Many will have OSPM as a part of another full-time role. These roles historically were filled by the community, where someone would have been running a big open source project. They're used to everything from advocacy to the licensing requirements. But it's not formal. There's no qualification for it. There's no specific training."

Sales and Marketing

Cian O'Maidin, CEO and founder of NearForm, the Irish software development company that developed the COVID Green application, commented on the skills gaps for sales and marketing:

"On the sales and marketing and the legal side of things in Ireland, however, there's definitely a skills gap. There's a lack of knowledge of the language and a lack of understanding of how to bridge from what they understand to actually getting the customer to understand it. There's that whole area of making it digestible for the customers, making it safe, that we're lacking in Ireland."

The need for technical marketing skills was shared by others:

"Technical skills are by far the most important for us, but also marketing – people that have experience of marketing these sorts of projects, that are developer-first, bottom-up." –Luke Feeney, TerminusX.

"Our marketing team is getting bigger and bigger, and I have to do education with them as well because they have to produce so much material. They have to learn quickly, they have to learn how to speak that lingo as well, because they're sitting in meetings with technical guys, telling them what they need, what they need to show people. But it's a very steep learning curve for the marketing guys." – Barry McGinley, EPS Global

Ger McMahon, Head of ALM Tools and Platforms at Fidelity Investments agreed and elaborated on how HR needed to understand the community to effectively recruit talent:

"There's a huge amount there that could apply to business people, analysts, legal. From a HR perspective, they'd also have to be familiar with open software and how it works – knowing where to go when looking to hire, how to interact with that community. It's also about educating the business leaders, the people in finance, on why this is why we want to invest in this way of working, what benefits are there to us as an organisation."

Licensing and Compliance

Developers tend to focus only on the technical side and lack consideration for other aspects, such as legal and compliance issues. Understanding the implications of these issues, such as the choice of open source license is important, as Fiona Manning of VMware described:

"Lots of questions need to be answered such as: how do you determine what licence to use? Is it compatible with your ecosystem? Is it compatible with how you want your product to grow? Just picking the right licence can be difficult."

Ger McMahon, from Fidelity Investments agreed:

"Understanding the licensing agreements of open source from a legal compliance security perspective is very important. Is this a good project, a safe project, is it set up correctly? Is it suitable for adoption in your organisation?"

John Phelan, ICT Research Commercialisation Manager at Trinity College Dublin shares the perspective from a third level institution:

"The skills in the university that are required are not technical. But the legal aspects – the appropriate licence, the pitfalls – that's where there would be some misconceptions. It's complicated and there are some polarised views – so I think it's really about education and understanding. It needs to be explained in a way that the technical people can understand without going into the real nitty-gritty."

Culture

A common theme across all the interviews was that working collaboratively and effectively with open source and InnerSource required a cultural shift within organisations:

"I think the difficulties are cultural. What's needed is a different ethos – a human-centric way to approach it. How do we incentivise people? How do we reward and recognise people? How do we share information on the value of InnerSource as a way of working – how it can drive and accelerate businesses and the business value?" – Ger McMahon, Fidelity Investments

"Over the years I've looked at change happen in organisations from different angles: some driven from the business domain, and some from the technical domain. And there's often a clash – that's why a lot of these changes don't go as well as they should or could have." – Tony Shannon, OGCIO

Lorraine Morgan, Senior Lecturer in the University of Galway, elaborated on the connection between communication skills and the ability to effectively practice InnerSource:

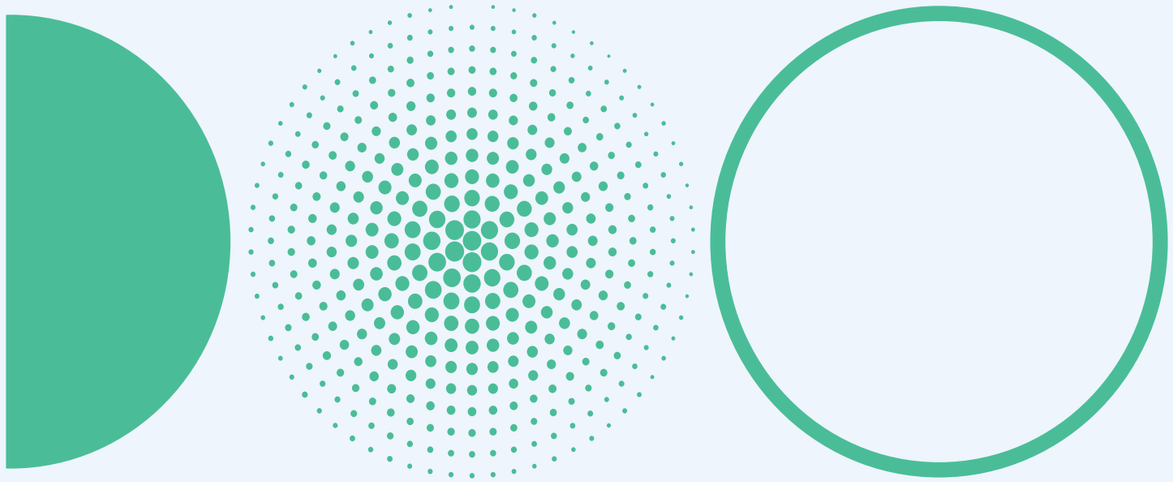
"One of the biggest skills required for InnerSource is effective communication skills (in terms of articulating needs and coming up with solutions). This is particularly important when dealing with globally distributed teams. "

One specific area that came up repeatedly was the need for communication around the business value for management and leadership, suggesting that a cultural shift must also focus on the board room. As Michelle Kearns, Head of IT at Boots Ireland explained:

"We need to be reaching business people and explaining the top line: 'this is what it actually means'. If you say you are going to open source something, it doesn't mean that people are going to steal your ideas. Even from an IT perspective, it's very difficult to explain it to someone. Who's responsible for the code if we produce something and someone uses it, or they change something, or they use it incorrectly? Who's liable? It's important to get non-IT people to understand it and a business to buy into it – it's that whole."

Danese Cooper, Founder of InnerSource Commons and long term open source advocate, elaborated on the need to shift perceptions more broadly around open source:

"I feel like most of the tech voices that I talked to in Ireland are still stuck with the fear, uncertainty and doubt, that was sown by certain large companies 20 years ago to try to stop the open source movement. It's been a long time since most of those rumours were credible. There's a gap because of this belief in these old systems, that needs to be closed in Ireland before anything else is going to happen. We need to expand our awareness about the reality of open source today."



While considering hiring or professional development activities by your organizations in the upcoming 3 years, how often will the following skills appear for technical roles?

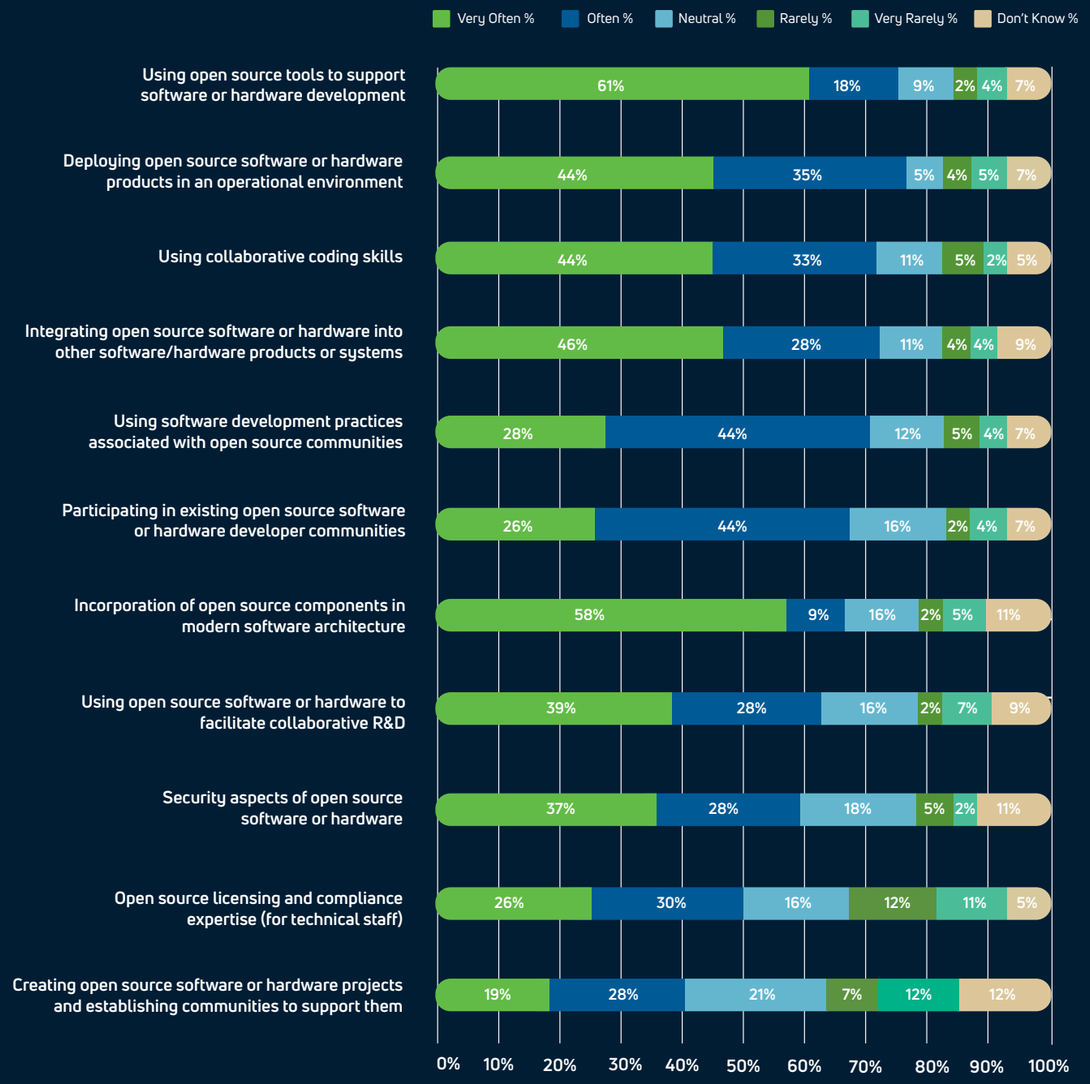


Figure 8. Technical open source and InnerSource skills required

Percentages may not sum to 100 due to rounding

While considering hiring or professional development activities by your organisations in the upcoming 3 years, how often do the following skills appear for any roles?

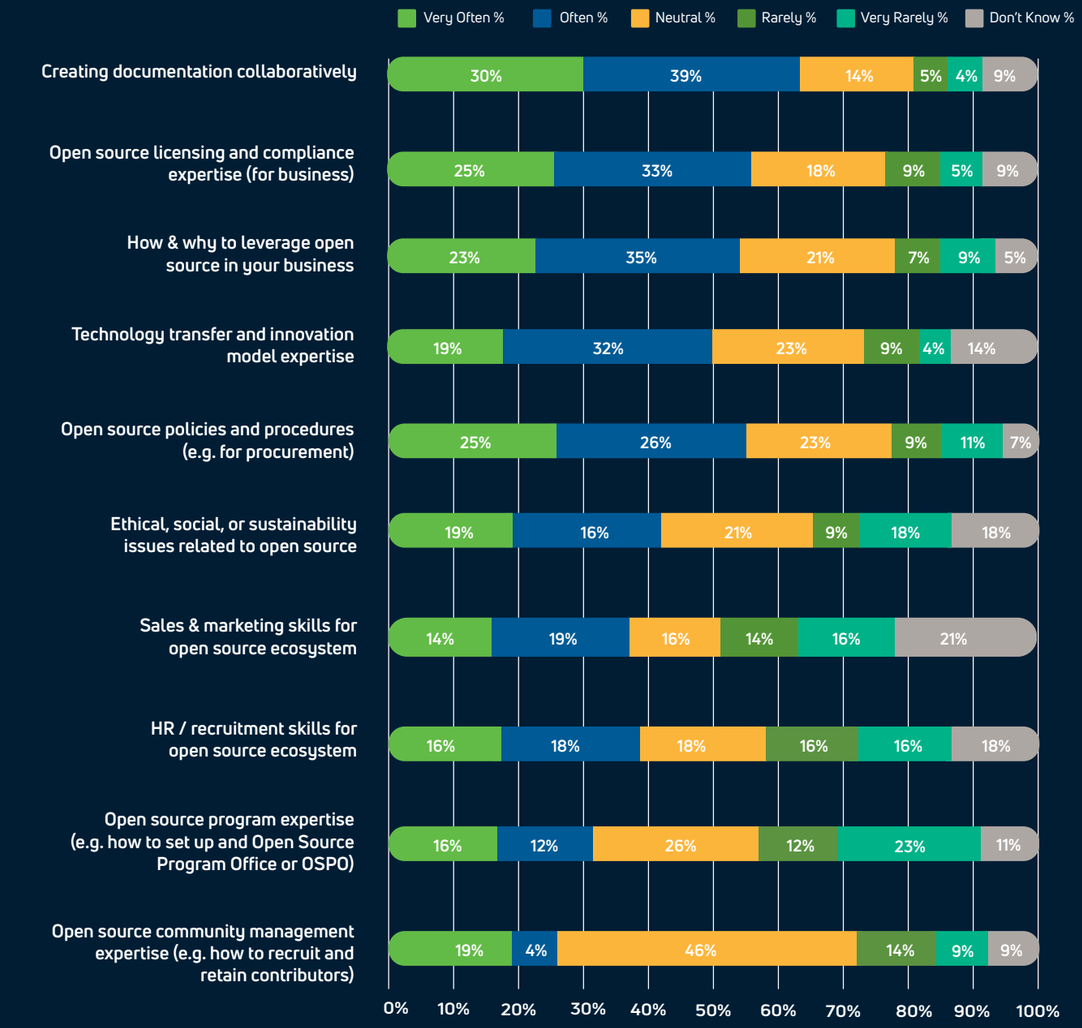


Figure 9. Other open source and InnerSource skills required

Percentages may not sum to 100 due to rounding

Increase in expectation of how often/very often do the following skills appear for technical roles in the future

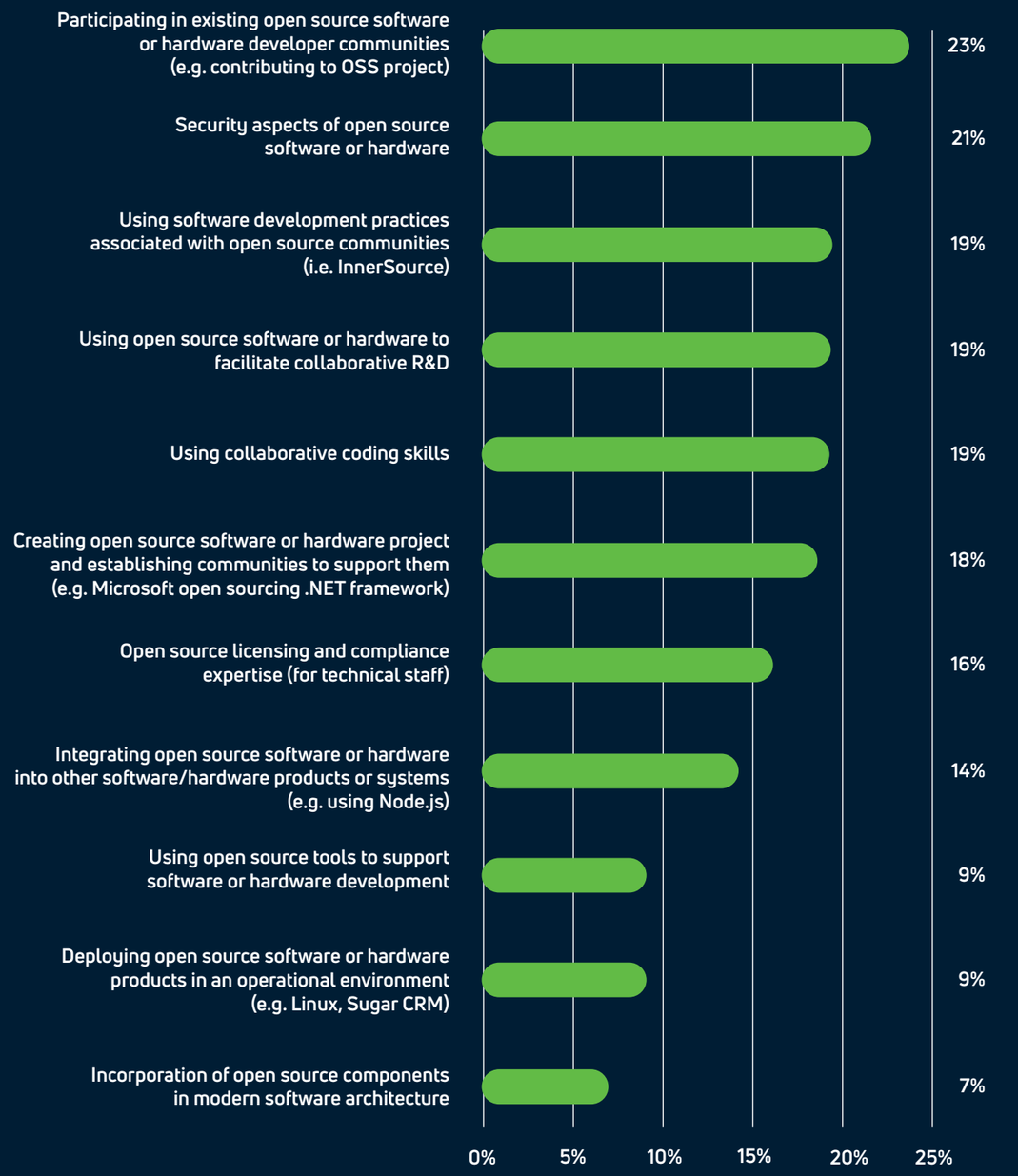


Figure 10. Increase in expectation of skills for technical roles

Increase in expectation of how often/very often do the following skills appear for any roles in the future

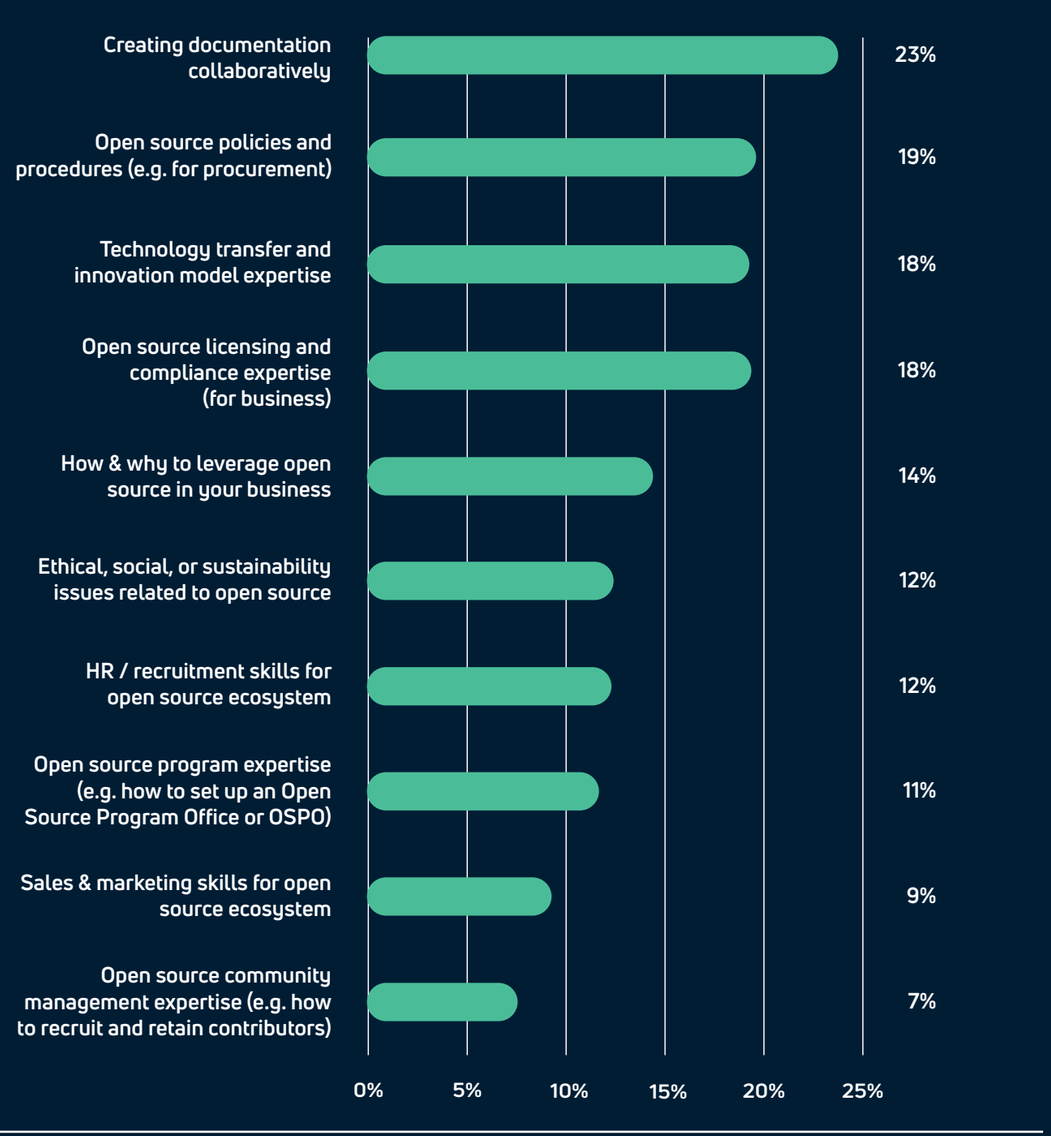


Figure 11. Increase in expectation of skills for non-technical roles

Learning Preferences

KEY LEARNING PREFERENCES
- Practical Experience Essential
- Community & Mentors Facilitate Learning
- Uplevel Through Flexible Courses & Accreditation

BIGGEST BLOCKER TO LEARNING
- Time Available to Learn

We asked survey respondents to indicate which ways of learning would be beneficial to learn new skills. Three themes of particular importance emerged during our data analysis:

1. Practical Experience
2. Community & Personal Connections
3. Formal Courses and Accreditation

Figure 12 presents the results of this question; in our discussion of these results, we focus on the proportion of respondents that answered 'beneficial' or 'very beneficial.'

Practical Experience

Almost all respondents agreed that building open source and InnerSource competencies requires practical experience. No less than 90% of respondents indicated that practical experience, such as contributing to, or using projects in the open source or InnerSource ecosystem was beneficial or very beneficial. Similarly, 86% indicated the importance of facilitated practical experience, for example a more orchestrated engagement with open source projects like that found in Google's Summer of Code.[38] Both the survey results in Stage 3 of our study, as well as the interviews in Stage 4 emphasised that getting hands-on experience was not just essential in building these skills, but that real-world experience in open source is what employers are searching for.

Many of the interviewees confirmed the findings of the survey, and noted how important it is to learn by doing when we are talking about open source or InnerSource. Adrian O'Sullivan from Huawei described how this might work:

"For third level, when people are doing projects, instead of starting on their own things from scratch, we should get them used to thinking what projects interest me? What do I use and compile and add to? Then they do it as a project but also learn to upstream their code."

Building on the idea, Adrian commented on how students' third level practical experience can be a great asset when looking for employment:

"We like to see a track record of community involvement. We would look at their GitHub account to see where people have been contributing – it's all public, that's the joy of open source. So if we can improve Ireland's contribution to open source even before people finish their education, it just makes them more attractive."

Apprenticeships were also suggested, both in terms of third-level students and in terms of expanding existing apprenticeship Programs to include open source technologies. Google's Summer of Code programme, which sponsors students to work on open source projects, was referenced as an example of how that can be achieved with students at third level.

"I would love to see universities being helped with, almost, summer apprenticeships – something like Google Summer of Code – where a small amount of money is found to encourage students to engage with an open source project, and with mentorship from experienced developers, learn how to work with the community." – John Looney, Reddit

Community & Personal Connections

A second category of preferred ways to upskill is through community and personal connections. 88% of respondents indicate attending regular community meet-ups would be beneficial, followed by attending conferences, workshops and tutorials (80%), mentoring Programs (67%), and peer-sourced learning experiences (64%), such as the InnerSource patterns community that codifies best practices. Community participation and mentorship is an important part of open source and InnerSource communities, and these themes were reflected in the interviews. Mentorship and low-barrier access to experienced people was suggested as playing a key factor in learning about open source and InnerSource. Interviewees emphasised the importance of mentoring and guiding people, to enable them to learn more effectively:

"You need to be guided, you need to be enabled, and you need to be able to ask all the stupid questions at the start, so that you don't feel like you're floundering. If we're looking at enabling people to go beyond where they are right now, I think it's a key offering that's missing on the training side in Ireland." – Anluan Dunne, Red Hat

"It also helps a lot to have a very senior expert who you can bounce your problem off. 'I have this problem. Do you know of a framework in which it might fit?' Because, otherwise, there's somebody new and they're not sure if their problem fits into this framework that exists out there. " – Mihai Todor, Optum

Mihai Todor, Principal Software Engineer at Optum, a US pharmacy benefit manager and health care provider described how communities create curated lists of recommended resources:

"And that's where I usually point people to 'awesome lists' on GitHub (https://github.com/topics/awesome), about DevOps, Kubernetes, data streaming. Those are curated lists that the community puts together. That's the best way to discover open source that I'm aware of."

This sharing of recommended resources within a community allows people to pursue their interests in their own time, asynchronously, rather than relying on synchronous meet-ups. Given the vast amounts of information on the internet, such curation helps people greatly to focus on resources that others have found useful, rather than having to waste time on less useful resources.

Formal Courses and Accreditation

A third way to upskill is through formal accreditation and courses. Although many the respondents said they would find them beneficial, formal training such as postgraduate courses (56%), degree courses (51%), and conversion courses (46%) didn't seem to be as attractive as other upskilling options discussed above. We note that virtual training courses, such as those offered on the Coursera platform were of interest (76%), as was formal accredited training, such as certificates or diplomas, other than formal degree Programs. Brian Farrell from Securelinx referenced a need for more individuals with industry accreditation such as Red Hat certified engineers or LPI [Linux Professional Institute]:

"[T]hey're all pluses for us because it means that somebody has demonstrated a measurable capability to begin with."

Anluan Dunne from Red Hat explained how the same types of certifications can be used to uplevel individuals who might be introduced to the area through ad hoc work involved in office admin:

"You have a lot of people who began their career after college or a post-leaving certificate in computer systems who fall into being an office administrator that ends up replacing toner but they also might do a little bit of server administration or maintain the website. There's no reason why they shouldn't be enabled to develop beyond that, so that they can do continual professional development in a way that allows them to continue in their job, maintain their income, but also increase their value so that they could then move to something else."

Another recurring theme was how industry representatives were keen to engage in the educational process. Partly there is a recognition in industry for a need to become part of the solution in the talent shortage in Ireland, as Ger McMahon of Fidelity Investments described:

"It's important to consider how industry can support these learning and education initiatives more. We're the ones who require the talent, so I think we've got to be part of the solution in generating that talent."

A willingness to be a part of the solution is one aspect, but it must also be clear what are viable ways for industry to get involved. Mihai Todor of Optum described that it is not always clear how industry could achieve this:

"At meetups I would get students saying 'hey, would you give a lecture?' And I was actually interested in that – I would love to go in front of a big auditorium and say 'hey, you know, here's this thing...' I just don't know how we can make that happen."

With the wealth of open source and InnerSource experience in Ireland, this could be an untapped resource that could be leveraged to accelerate open source and InnerSource skills locally and internationally.

Beyond the Computer Science Degree

Elaborating on the observation that we need more than just technical skills, Luke Feeney from TerminusX suggested that we do more at third level to introduce non-technical students to the benefits of open source:

"A lot of software developers will come out of university and they'll be familiar with how open source projects are organised. But people from other walks of life have no exposure to it at all. In business and marketing courses, there's just no exposure. It seems that we're missing out on a whole chunk of where growth is going to come from and technology in the future. " – Luke Feeney, TerminusX

Barry McGinley, Senior Systems Engineer at EPS Global suggested including some modules on the latest technology landscape which are frequently updated:

"Because our industry moves so quickly, and we'll be working with one operating system and then changing immediately, it's definitely learned on the job with us. With a degree course, it's going to be too late by the time they start, never mind when they finish."

McGinley also suggested that degree courses could include modules on the wider landscape of technology as an introduction on what is possible, and what career paths students could take.

"Even just modules on your career and what's possible, and the industry in general, would be good. We didn't do anything on bare metal – the whole server industry is bare metal, is virtualised, and we didn't touch it. So getting them at the first or second year of their degree courses and showing them something different, that's when you need. You need to be putting ideas into people's heads about different career paths and what could be possible."

"The first [suggestion on how to close the skills gap] would be an open source roadshow, which would serve as both a marketing exercise and an educational exercise. You can't innovate on something if you don't know it exists... By using tangible, real-life examples, you have a way of communicating the benefits of open source and collaborative development that people can apply to their lives and businesses. " – Anluan Dunne, Red Hat

The interviewees also had a number of suggestions in terms of specific learning preferences and alternative ideas about how to engage students, and even which students to engage. Short, snappy, online modules that people can do at their own convenience. A forum to support that would be useful as well, something like:

"here you can all share your knowledge, share your learning." – Michelle Kearns, Boots Ireland

"We need to transition to a more scalable and sustainable approach to digital transformation that I believe should be interwoven with an open source methodology. The difficulty with any training is that training modules will usually come from one perspective/dimension [...] One way to do that would look at digital transformation projects combining user-centred design, agile application development, leveraging open source frameworks. This could also provide the basis for a useful curriculum that a broad variety of staff would benefit from. [...] So again these people–process–technology skills need to be taught, perhaps as different modules in an overall program of 21st Century digital change. " – Tony Shannon, Office of the Government CIO.

More details on respondents' learning preferences can be found in Figure 12.

Barriers to Upskilling

While upskilling was clearly found to be important, it doesn't come for free. Barriers exist, and by far the biggest constraint to learning is time, either personal time (73%) or time available at work (68%). Related to available time at work may be the suggestion that organisational priorities are also likely to limit learning in this space (45%). This suggests that learning might be facilitated by formal Programs allocating time for individuals to devote to upskilling.

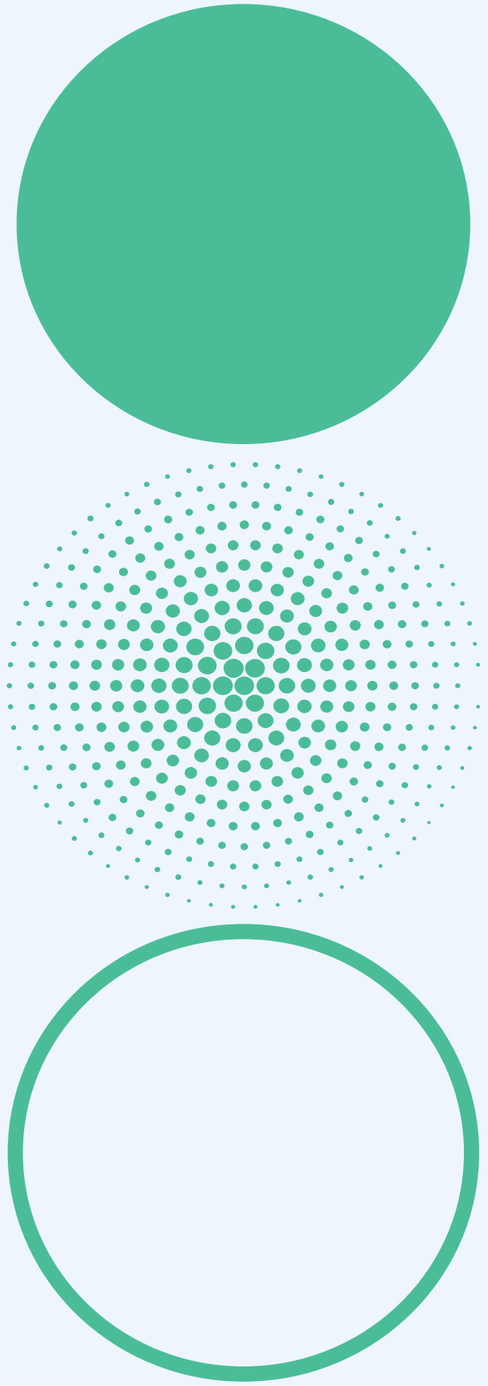
40% indicated that the availability of learning options could limit the ability to upskill. 31% percent indicated that cost plays a role, indicating that organisations do not explicitly commit to offering their staff opportunities to free training. Only 27% of respondents indicated that personal interest would be a blocker, indicating that most respondents are interested in pursuing further upskilling. 24% of respondents indicated that the environment could be a barrier, indicating that organisations may not have an open source project culture. A number of the interviewees specifically called out the challenges relating to Small and Medium Enterprises (SMEs)

"The open source side of things has a far larger, more tangible impact on Irish SMEs than is realised. Irish SMEs and start-ups who are spinning up a new product to solve a niche problem are going to do it on a piece of community open source software first; then they're going to productise it; and then they're going to support it. And if we're not supporting that, we're not supporting them. From an all-Ireland perspective of investing in this, that's how we should be coming at it – support our own." – Anluan Dunne, Red Hat

A concern of SMEs as well is that upskilling staff makes them more attractive to large organisations "with deep pockets" who could poach staff once they earn certifications. This poses a risk to SMEs who might see their talented staff leave for better offers:

"If we can get people who already hold certifications and accreditation that we recognise – like Red Hat certified engineers, LPI [Linux Professional Institute] – they're all pluses for us because it means that somebody has demonstrated a measurable capability to begin with. But these skills are very sought after, and they're very sought after by very large organisations with very deep pockets. Ireland, being so successful in terms of its ability to attract companies and technology companies, has a particular problem keeping up with the demand for those skills. There's an arms race for talent right now. In Ireland, there's obviously the household names that are here, yet there is a real requirement for independent local organisations to back up the IT sector and ecosystem. If we increase the talent pool, there's multiple options for people in terms of where they go. If they don't all end up with the big companies, I'd like to think that there's more of a chance of independence, because that drives innovation, creates more local, 'sticky' jobs, and creates more value."
– Brian Farrell, Securelinx.

More details on perceived leaning constraints can be found in Figure 13.



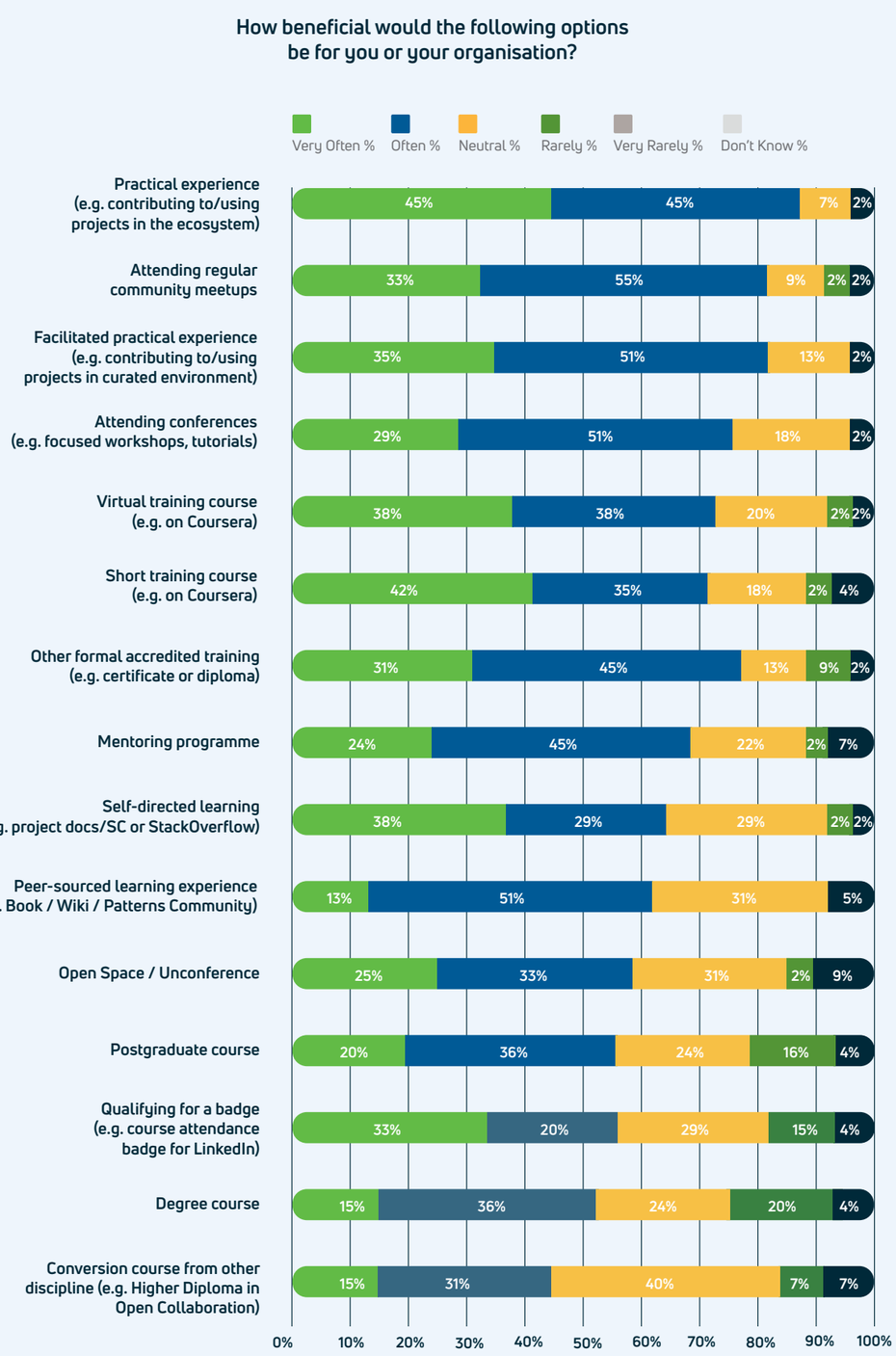


Figure 12. Learning preferences

Percentages may not sum to 100 due to rounding

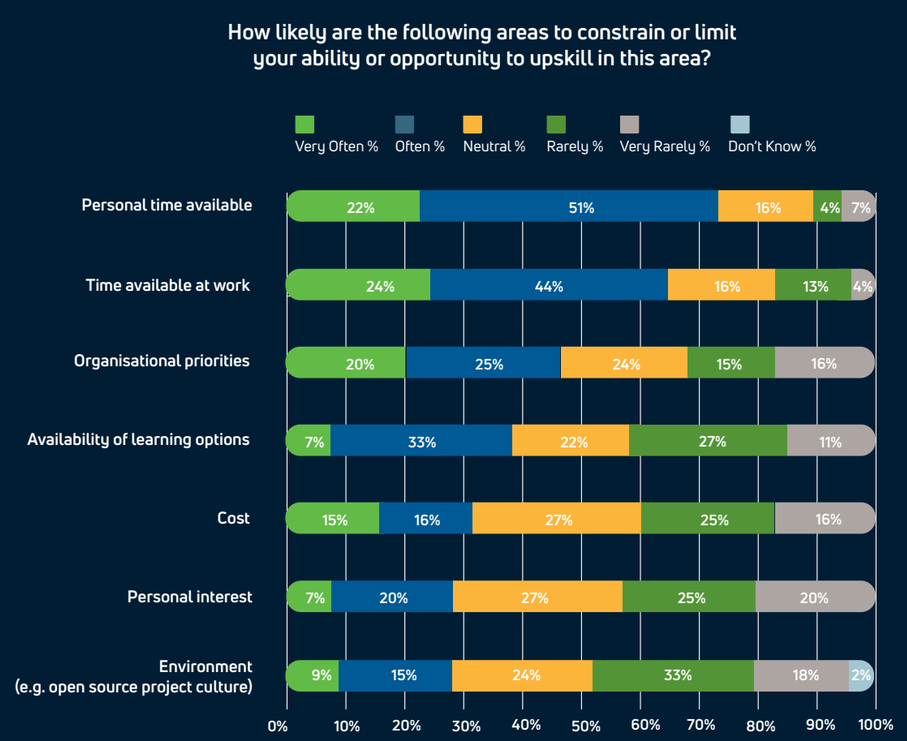


Figure 13. Learning constraints

Percentages may not sum to 100 due to rounding

Demographics

The majority of the respondents (66%) hold technical roles, with 42% holding roles at C-Level or IT Management. All our respondents were over 30 years of age, with the largest cohort (44%) aged between 40-49. Like most surveys in this sector, the overwhelming majority of respondents (88%) were male, highlighting a lack of diversity in this field.

Firmographics

Just over half (53%) of the respondents work in the Technology domain, the remaining respondents are spread over a wide variety of verticals including Public Sector, Education, Telecoms or Media, Healthcare, Financial Services and Retail. Organisation size varied widely, from less than 50 employees, to over 10,000. Most of the organisations (53%) are headquartered in Ireland, with 29% from the US and others from the UK, Germany, Canada, Sweden and China. The vast majority (76%) of respondents are based in Dublin.

Respondents were asked if they would like to share their organisation name. This question was not compulsory. The responses are listed in the table below and give an indication of the diversity of the organisations who responded.

Akkure Medical	HG Insights	National College of Ireland
Altada	HSE	Optum
Biild	Huawei	Red Hat
Boots Ireland	IBM	Securelinx Limited
Central Bank of Ireland	Informatica	TerminusX
Eclipse Foundation	Manakau	Trinity College Dublin
EPS Global	Meta	University College Cork
EY	Microsoft	WorkHuman
Fidelity Investments	MongoDB	
Flax & Teal Limited	MRL IT Consultancy Ltd	

Table 3. Sample of respondent organisations

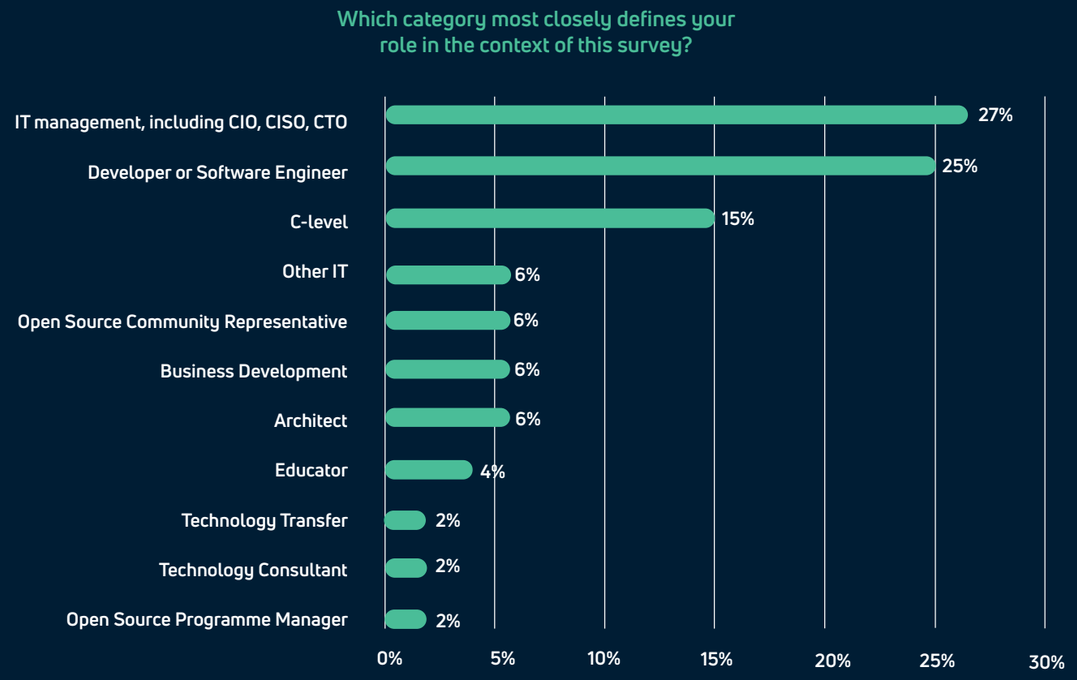


Figure 14. Individual roles of respondents

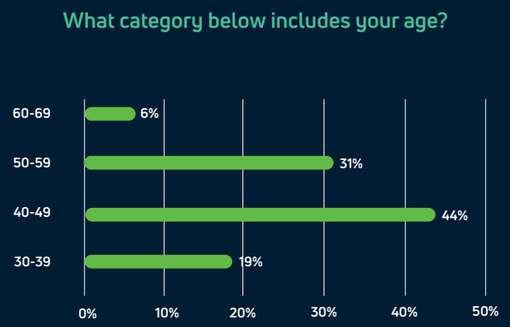


Figure 15. Individual age ranges of respondents

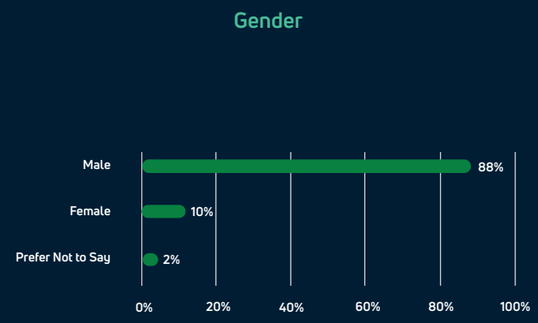


Figure 16. Gender of respondents

Percentages may not sum to 100 due to rounding

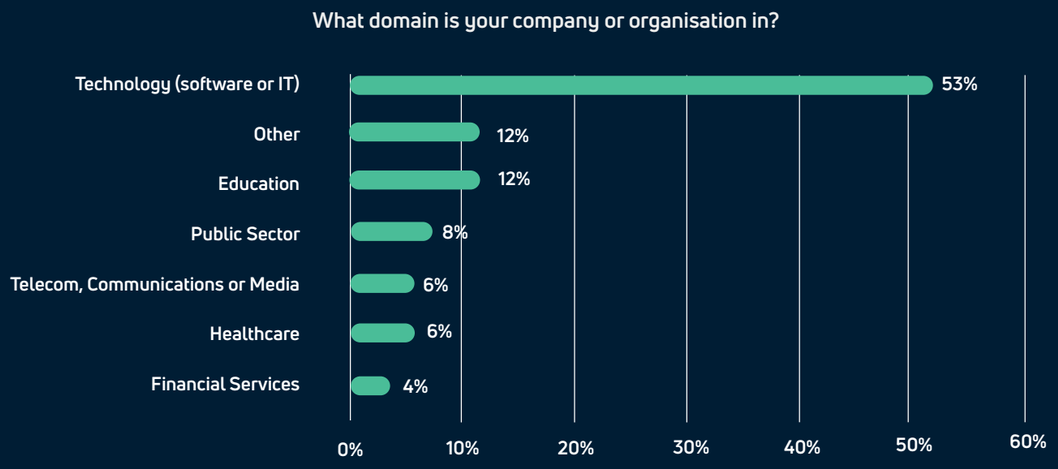


Figure 17. Organisation domain

Percentages may not sum to 100 due to rounding

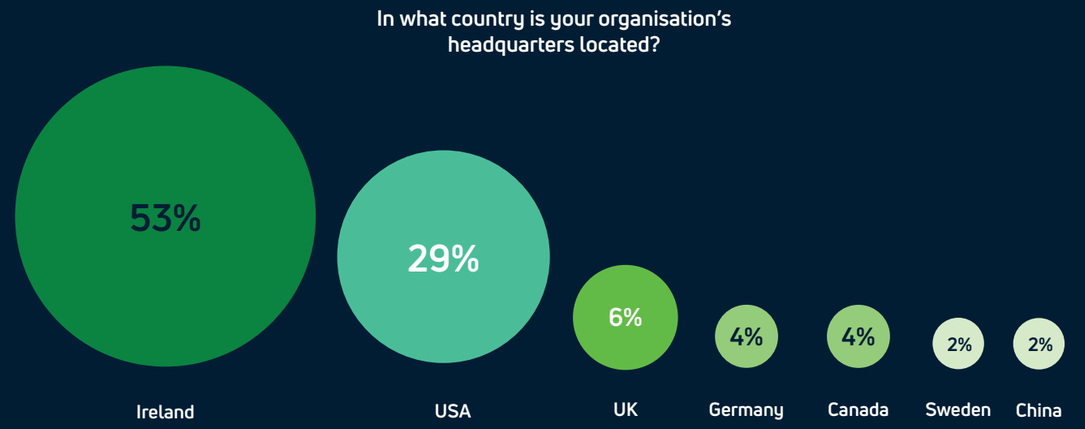


Figure 19. Organisation headquarters location

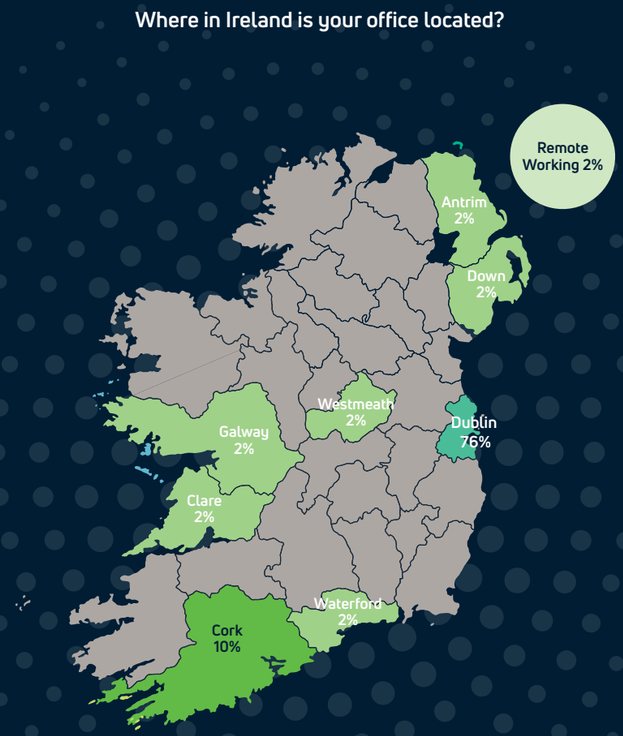


Figure 18. Respondent office locations

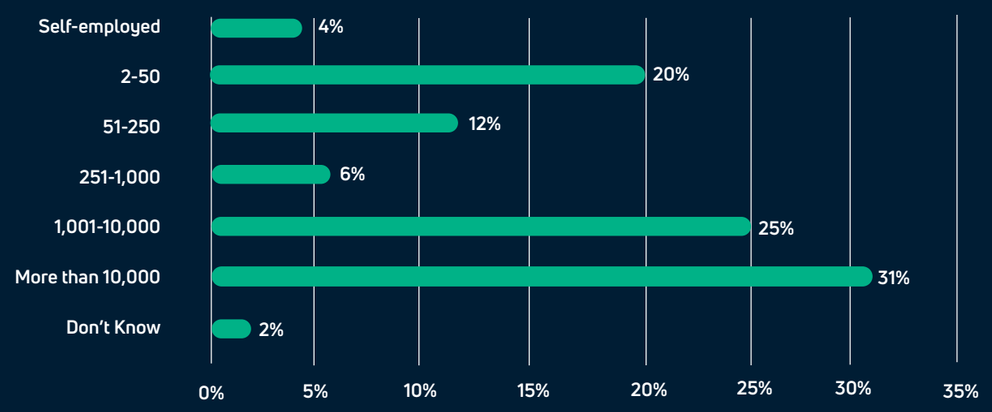


Figure 20. Size of respondent's organisation

Recommendations & Conclusions

A key outcome of this study is that there is a clear need for more skills related to open source software and InnerSource. The study has outlined the key advantages to leveraging open source and InnerSource in companies based in Ireland. It is clear from the research that there is a broad set of skills required for optimal use and creation of open source software and hardware, and the practice of InnerSource. Although there are many examples of skilled open source and InnerSource practitioners in the community, these skills are not yet readily available in the Irish market. There is a "race for talent", and without training more people on these much-needed skills, this poses a real danger to the sustainability of the Irish digital ecosystem.

Whereas many open source and InnerSource learning resources currently focus on the needs of technical audiences, this study also highlighted the need for related skills among the non-technical community to support the ecosystem. If we focus on building skills in these areas, there is an opportunity for Ireland to become the premier location in the world for open source business talent.

Table 4 presents a preliminary SWOT analysis of the Irish Open Source and InnerSource Skills Landscape.

To address the current and emerging skills needs of the Irish open source and InnerSource ecosystem, we recommend the following five actions. All five recommendations could be implemented as part of a comprehensive new Skillnet program addressing the open source and InnerSource skills gap and rolled out in the 2023-2025 timeframe:

1. Curate a directory of existing open source and InnerSource learning resources.

The global open source ecosystem is also working to address the acknowledged skills gap. For example, there are many learning offerings available for particular open source projects and technologies. We recommend investigating, listing, and curating existing learning resources related to open source and InnerSource that are currently available and accessible to Irish IT professionals and developers. An initial resource list could be crowd-sourced by the local open source and InnerSource community and published on the Open Ireland Network community website in 2023. An important aspect of this action is to maintain this list to remain relevant. The outcome of this action will result in increased access to the existing learning for Irish IT professionals that is available in the local and global open source and InnerSource ecosystems.

Table 4. Preliminary SWOT Analysis of Irish Open Source and InnerSource Skills Landscape

Strengths	Weaknesses
• Well-established software industry, with core set of experienced open source and InnerSource practitioners. • Ireland has an ability to be agile when it comes to addressing skills needs.	• Shortage of open source and InnerSource skills in Ireland, particularly felt by indigenous firms. • Lack of leadership and management understanding and buy-in for open source and InnerSource.
Opportunities	**Threats**
• Irish firms accelerate innovation, improve code quality, increase developer productivity, and experience the other benefits of leveraging the full potential of open source and InnerSource. • Ireland emerges as the premier place to recruit business talent for organisations participating in the open source and InnerSource ecosystems.	• Irish start-ups and SME sector are at a competitive disadvantage in the global market; large organisations may hunt for talent. • Ireland may reduce its attractiveness to global organisations due to a lack of available skilled labour.

2. Create innovative open source and InnerSource learning Programs.

This study identified a number of suggestions for innovative approaches to building open source and InnerSource skills, including introducing practical hands-on experience of open team collaboration in existing computer science courses, more community, peer or mentor-led engagements, and the deeper involvement of industry in the creation and delivery of related learning resources. We recommend the design and implementation of some pilot learning Programs focusing on open source and InnerSource, leveraging the insights in this study. Such training could be created and rolled out over the 2023-2024 timeframe and should address the three audiences identified in the report: C-level leadership, technical roles, and non-technical business roles, and be available in a variety of formats, for example, accredited Programs, self-paced online learning or community engagements. A consequence of focusing on this area will not only deliver more options for upskilling personnel in Ireland, but it can also provide new learning options for a global market of open source and InnerSource practitioners and position Ireland as a leader in this space.

3. Extend the existing Skillnet portfolio with open source and InnerSource Programs.

There is an opportunity to build on existing Skillnet information technology Programs to deliver additional training options to address the open source and InnerSource skills gaps identified in the report. Relevant training modules could be created to transverse existing Skillnet Programs, for example in the areas of DevOps, Cybersecurity, AI, Blockchain and Internet of Things. As with all these recommendations, we propose that any such Programs are designed in close collaboration with relevant stakeholders across the ecosystem to best identify priorities and expectations, and maximise impact.

4. Support the establishment of OSPOs in educational institutes.

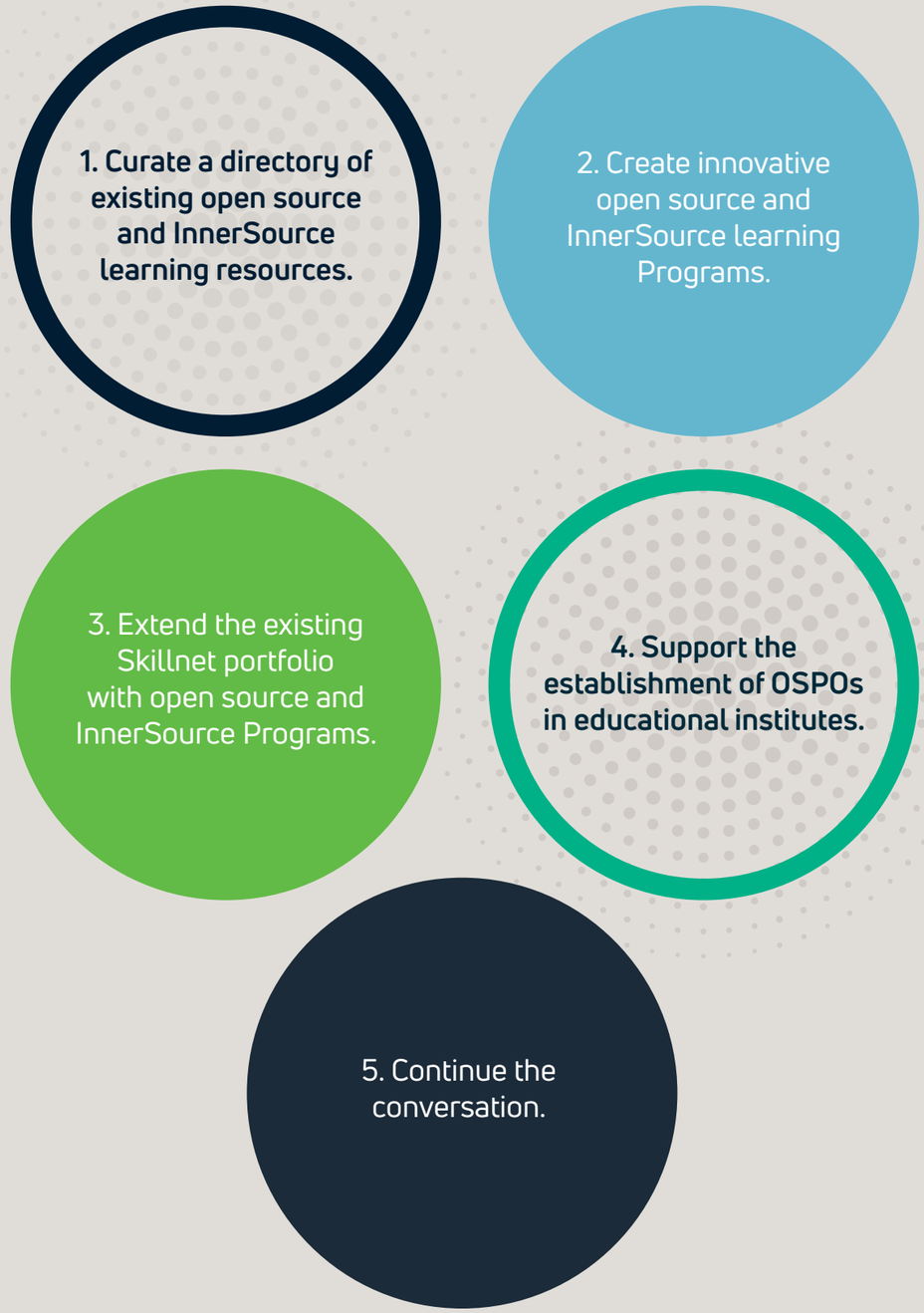
The European Commission report on economic impact of open source[40] included a recommendation for the creation of open source program offices (OSPOs) in educational and government settings. The OSPO in Trinity College Dublin (TCD) is the first University OSPO in Europe. OSPOs in academic institutions often play an important role in the creation and roll out of open source or InnerSource education Programs within third level colleges and universities. University OSPOs that form part of established global networks, for example the OSPO++ Network, can also leverage and extend educational Programs in other universities globally. We recommend the establishment of additional OSPOs in additional Irish universities to support the creation and roll out of open source and InnerSource educational Programs in our third level institutions. Such OSPOs could also facilitate effective triple helix collaborations[41] with OSPOs in industry, governments, and non-governmental organisations to help deliver the kind of practical experience required. Whereas the decision and investment required to establish an OSPO would be the decision of each individual educational institution, a Skillnet programme could include engagements with interested institutions to help assess the potential, support the planning phases, and upskill staff to work with and for University OSPOs. Such a program could be put in place in 2023, with a view to supporting the establishment of new University OSPOs within the 2024-2025 timeframe.

5. Continue the conversation.

This study is only the start of a valuable conversation. Taking inspiration from how Ireland moved quickly into a leading position in the EU with open data,[42] we should engage with companies, academic institutes, government, and Irish society to explore how we might further develop our position as a global leader in the open source and InnerSource ecosystem. We recommend ongoing follow-up studies over the coming years, seeking larger participation from the wider Irish technology ecosystem, to revisit and evaluate ongoing initiatives.

We conclude that, like our journey with open data, Ireland has the potential to be a leader in the field when it comes to open source and InnerSource. Investment in open source and InnerSource skills and talent directly aligns with Europe's strategy for a Digital Europe. Moving to act on the points outlined above can help position Ireland as a thought leader and front-runner for the world's open source and InnerSource ecosystems, and a destination for related talent and skills development.

Summary of Recommendations



Acknowledgements

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Clare Dillon has over 25 years' experience working with developers and developer communities. In 2021, she was appointed the Executive Director of InnerSource Commons. In 2021, Clare co-founded Open Ireland Network, a community for those in the open ecosystem in Ireland. Clare also works with the OSPO++ Network to support the establishment of University and Government Open Source Program Offices globally. Before that, Clare was a member of the Microsoft Ireland Leadership Team, heading up their Developer Evangelism and Experience Group. Clare is currently a PhD researcher in School of Business and Economics at the University of Galway.

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Partner Organisations

Open Ireland Network

Open Ireland Network is a community of individuals and organisations who are involved in the open ecosystem in Ireland, encompassing open source software, InnerSource, open source hardware, open data, open science, and open innovation. The network includes representatives from industry, public sector, academia and those who are personally involved in the open ecosystem. The network is a volunteer organisation set up with the support of Technology Ireland ICT Skillnet. **Find out more at www.openirelandnetwork.com.**

Lero

Lero, the Science Foundation Ireland Research Centre for Software, brings together expert software teams from universities and institutes of technology across Ireland in a co-ordinated centre of research excellence with a strong industry focus. Lero's research spans a wide range of application domains from driverless cars to artificial intelligence, cybersecurity, fintech, govtech, smart communities, agtech and healthtech. Lero is ranked second among software research centres worldwide for citations. Headquartered at University of Limerick, Lero involves 12 academic institutions across Ireland. **Find out more at www.lero.ie.**

Trinity College Dublin

Trinity College Dublin is Ireland's highest ranked university. It is home to 18,000 undergraduate and postgraduate students across all the major disciplines in the arts and humanities, and in business, law, engineering, science, and health sciences. Trinity's Open Source Programme Office (OSPO) is a division of the Office of Corporate Partnership and Knowledge Exchange and has been established with the objective of promoting and supporting the principles of open source and open data, in knowledge transfer and industry engagement within Trinity College. **www.tcd.ie**

OpenForum Europe

OpenForum Europe (OFE) is a not-for-profit, Brussels-based independent think tank which explains the merits of openness in computing to policy makers and communities across Europe. **Find out more at www.openforumeurope.org**

OSPO++ Network

OSPO++ is a network and a community of collaborative open source programme offices in universities, governments, and civic institutions. They are building resources to help create OSPOs, actively engaging in discussions on how to best manage and grow open source Programs, and how to garden sustainable communities that last. **Visit www.ospoplusplus.com to find out more.**

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