European Commission

Report on the role of open source in the digital response to COVID-19 in the EU

A focus on the health and education sectors

DG DIGIT - Unit.D2 (Interoperability Unit)

ISA²

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WAVESTONE

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Picture on cover page: unsplash.com

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Foreword

The strength and value that open source products bring to public sector organisations and companies is recognised, yet the pandemic has heightened the need for digital resilience in new ways. The Open Source Observatory (OSOR) provides a wealth of information on how to adopt open source, when to adopt and how to nurture products and open source communities. This report is further evidence of the robust effort made within the European Commission to encourage genuine choice in software use and adoption where licence decisions and quality software are important.

This report focuses on open source products within two key sectors, health, and education. It offers data and information on specific open source products used in these sectors and explains why they were adopted. The pandemic has aggravated the difference between digital haves and have nots. Thus, governments need to work harder to give access to basic amenities like health and education to everyone. This is exactly why open source is a relevant mechanism to inculcate ideas of freedom, choice, access for all and equality.

This report is helpful in showing public sector organisations the philosophical as well as practical power of open source adoption, but it especially gives advice for digital resilience through open source during the current pandemic. Open source is known for its infrastructure strength. However, there is a growing number of open source applications whose use and functionality became a powerful resource during the pandemic. This report offers a well-balanced view on such open source applications. It also traces the origin and need of significant products such as COVID-19 tracker applications to showcase the capability of open source and its ability to adapt to different crises.

OSOR collected data across European countries to write this report, which is written clearly and comprehensively. Public sector organisations in Europe and beyond will find its analysis to be beneficial.

Maha Shaikh

King’s College London

25/07/2021

Introduction

Since January 2020, the COVID-19 pandemic has led to a health crisis that hampered the functioning of public services in the European Union (EU) and beyond. Almost all of the 27 EU Member States imposed lockdowns[1] on their populations, which disturbed the daily activities of citizens, businesses and public administrations. The crisis created new challenges for the public sector, with 19 EU Member States reporting a disruption in the provision of public services during the first wave of the COVID-19 pandemic[2]. To ensure continuity, European public administrations relied on digital solutions to deliver their services remotely[3].

As a result, the ongoing COVID-19 pandemic has emphasised the importance of digital public services and of building digital capacity within public administrations to foster resilience in times of crisis. Specifically, it has demonstrated how the sectors of health and education stood to benefit the most from the development and/or implementation of digital solutions to ensure the continuity of their delivery[4]. The health sector is understood in this report as stakeholders or institutions whose goods and services have principally or exclusively the objectives to safeguard the health of individuals or populations and/or advance medical research. The education sector encompasses institutions (e.g. Ministries of education, local educational authorities, teacher training institutions, schools and universities) whose primary purpose is to teach pupils in educational settings.

Many of the digital solutions that supported both sectors were released as open source software (OSS)[5] by developers, open source communities[6], and public and private bodies.

This report explores the role of OSS in the digital response to COVID-19 across the EU, focusing on good practices and successful reuse cases of OSS in the health and education sectors between January 2020 and January 2021[7].

This report has the following objectives:

- **Objective 1**: provide an overview of the involvement of the open source community in the development of health and education OSS in response to the COVID-19 pandemic.
- **Objective 2**: showcase the health and education-related open source solutions which have enabled EU countries to respond to the COVID-19 pandemic.
- **Objective 3**: explore the advantages of relying on open source solutions as part of EU public administrations' digital response to the COVID-19 pandemic.

[1] Analysis of the data gathered by the European Centre for Disease Prevention and Control (ECDC), performed by Wavestone, November 2020.
[2] Survey performed by Wavestone, November 2020. The 19 countries that declared a minor, moderate or significant disruption of their public services during the first wave of the COVID-19 pandemic are: Belgium, Bulgaria, Croatia, Cyprus, Finland, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia, Slovenia and Sweden.
[3] European Commission, *Public administrations' digital response to COVID-19 in the EU*, Publications Office of the European Union, Luxembourg, 2021.
[4] Survey performed by Wavestone, November 2020. 73% of Member States chose health and education as the public services mostly concerned by the development and/or implementation of digital solutions.
[5] OSS refers to software for which the original source code is made publicly available and may be redistributed and modified.
[6] Open source communities refer to a group of individuals who work together to develop, test, modify or support OSS products.
[7] Although this report's data collection exercise focused mostly on EU public administrations and their use of OSS, some solutions mentioned in the report were developed outside of the EU as the open source community is present worldwide.

- **Objective 4**: analyse the good practices EU public administrations have leveraged to promptly develop and/or deploy open source solutions as part of the digital response to the COVID-19 pandemic.

Finally, the report's conclusion reflects on the impact of the COVID-19 pandemic on public administrations' perception of open source.

1 Involvement of the open source community in the digital response to COVID-19

When the COVID-19 pandemic began impacting the activities of public administrations, new digital solutions were needed to answer newly raised questions. How can the spread of the pandemic be limited? How can cases be tracked and traced? How can schools switch to remote education? How will citizens adapt to lockdown measures? Across Europe, calls for contribution to solidarity efforts were launched, asking people from all parts of EU society to put their heads together and find solutions to the problems caused by the COVID-19 pandemic. The principles of open source, based on transparent development and knowledge sharing, encourage developers around the world to collaborate, help improve each other's projects and make useful resources available to others. In accordance with these values, the open source community has unsurprisingly united to respond to these calls and actively contributed to the digital response to COVID-19.

This section explores the types of contributions made by the open source community and the activities that fostered collaboration amongst developers to create or improve OSS (e.g. hackathons). The responsiveness of the open source community and its contribution to the digital response to the pandemic were assessed using the Digital Response to COVID-19 collection on the Joinup platform[8] (hereafter 'the DRC collection'), complemented by additional desk research. Created by the European Commission, the DRC collection gathers more than 500 global digital solutions which aim to help public administrations, businesses and citizens address the consequences of the crisis.

This report will focus in particular on the health and education sectors. As detailed in the report on the digital response to COVID-19 in the EU[9] published by the National Interoperability Framework Observatory (NIFO)[10], 73% of EU Member States indicate that the development of COVID-19-related digital solutions was most relevant for education and health services. The predominance of open source solutions for these domains is also noticeable within the DRC collection, where 74% of OSS is related to either health or education[11]. As of June 2021, the DRC collection counted 142 open source solutions related to health or education, gathered through desk research and voluntary submissions. The sample for analysis in this report is composed of these solutions and thus may not be representative of the overall situation in all EU Member States. As such, the sample comprises both solutions that were specifically developed from January 2020 onward in response to the COVID-19 pandemic and pre-existing solutions which proved useful in this context.

Contributions from the open source community to the digital response to COVID-19

To analyse comparable data, a deeper analysis was performed on a sample of solutions from the DRC collection whose repository is publicly available on popular hosting platforms such as GitHub[12],

[8] Further information available at: https://joinup.ec.europa.eu/collection/digital-response-covid-19/open-source-solutions.
[9] European Commission, *Public administrations' digital response to COVID-19 in the EU*, Publications Office of the European Union, Luxembourg, 2020.
[10] Further information available at: https://ec.europa.eu/isa2/solutions/nifo_en.
[11] Calculation on the basis of the 194 open source solutions present in the DRC collection on 21 June 2021.
[12] Further information available at: https://github.com/.

SourceForge[13] and GitLab[14]. An OSS repository is understood as the central location in which the data related to the source code of an open source solution is stored. The selected sample amongst the solutions identified for this report includes 99 OSS repositories that were created between January 2020 and January 2021.

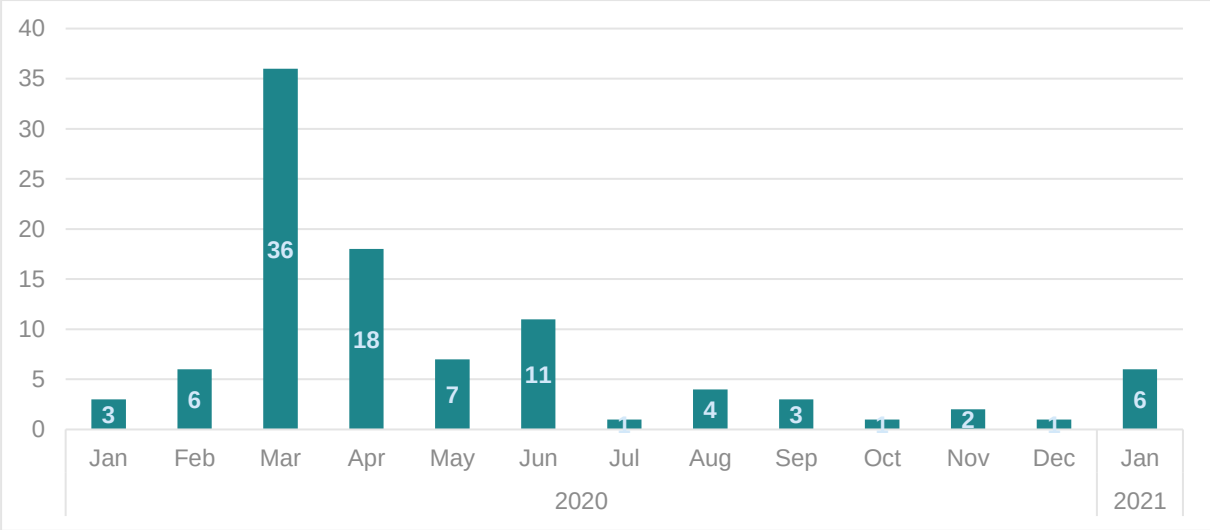


Figure 1 Amount of repositories created in response to the COVID-19

Source: analysis performed by Wavestone using data from the DRC collection, June 2021.

Figure 1 illustrates a peak in the creation of OSS repositories in the first few months following the spread of the pandemic across the EU. 61 of the 99 OSS repositories included in the sample of analysis were created between March and May 2020. This is a sign of the **responsiveness to COVID-19 of public and private organisations within the open source community**.

The initial response to the crisis by the open source community showed an almost exclusive focus on health-related solutions. 31% of the solutions developed in the first three months of the COVID-19 pandemic focused on providing contact-tracing tools to limit the contamination of citizens. In total, 59% of the open source solutions developed at the beginning of the COVID-19 pandemic were designed for citizens' usage, including contact-tracing apps such as the Cypriot government's COVTRACER[15], information portals like the Romanian government's 'What to do' (*Ce trebuie să fac)*[16] and auto-diagnosis tools such as the Open COVID19 test[17] based on the solution of the Autonomous Community of Madrid.

By contrast, the analysed DRC collection data from January 2020 to January 2021 includes few solutions targeted at health professionals, constituting just 21% of the sample assessed in this report. Furthermore, these solutions only account for 10% of the OSS releases in the first months of the crisis. This may be explained by a focus on supporting researchers in understanding the virus. Indeed, OSS targeted at researchers represents 29% of the releases, with a specific concentration of solutions for epidemic modelling. Additionally, open source communities might have faced challenges in supporting hospitals and health organisations with legacy IT systems that typically hinder the provision of external

[13] Further information available at: https://sourceforge.net/.
[14] Further information available at: https://about.gitlab.com/.
[15] Further information available at: https://covtracer.dmrid.gov.cy/dmrid/covtracer/covtracer.nsf/home_en/home_en?opendocument.
[16] Further information available at: https://cetrebuiesafac.ro/.
[17] Further information at: https://celiavelmar.github.io/open-covid19-test/.

support. A more in-depth explanation of the types of solutions developed by the open source community is provided in Section 0.

Collaboration within the open source ecosystem

The magnitude of the COVID-19 pandemic has encouraged the open source community to further exchange feedback and work together, resulting in an **increased level of community collaboration**. This joint effort has also been driven by discussions around the release and publication of open datasets and code bases to increase the pace of scientific development and innovation in the context of vaccines. A salient example of such collaboration is the Johns Hopkins University (US)[18] repository gathering COVID-19 open datasets published under open standards and releasing the code of its epidemic modelling[19] software as open source. This endeavour involved more than 260 open source communities and public administrations providing data to the repository. Similarly, the World Health Organization's open platform[20] based on the OSS OpenClinica[21] was created to gather intelligence from several countries, help users visualise and analyse data on the outbreak of COVID-19, and identify trends. EU public administrations have benefited from this worldwide collaboration, reusing the OSS available to them to support the digital delivery of their public services and the health response to COVID-19.

Enhancing the involvement of the open source community through hackathons

In addition to creating OSS repositories, the open source community united by organising and attending hackathons and events aimed at fostering knowledge sharing and collaboration, and boosting the development of digital solutions in response to the COVID-19 pandemic. The DRC collection gathered information on the organisation of 20 hackathons in the months of March and April 2020 alone, and a total of 30 throughout 2020. Almost half of the hackathons sampled were organised by the public sector. Several European governments hosted national hackathons to encourage the development of digital solutions, facilitate the search for investments to speed up the solutions' time to market, and serve as networking platforms. The German Federal government launched the **Wir vs. Virus hackathon**[22] on 20 March 2020, where 28 361 professionals worked together on over 1 500 solutions in 48 hours. Similarly, in Greece the Ministry of Digital Information launched the **Greece vs. Virus hackathon**[23] on 15 June 2020. In April 2020 the European Commission launched the **EU vs. Virus hackathon**[24] to boost the development of innovative solutions tackling the COVID-19 pandemic and support creators in their search for investments.

[18] Further information available at: https://systems.jhu.edu/research/public-health/ncov/.
[19] Epidemic modelling solutions allow users to analyse data and simulate the global outbreak dynamics of infectious diseases through algorithms.
[20] Further information available at: https://www.who.int/teams/health-care-readiness-clinical-unit/covid-19/data-platform.
[21] Further information available at: https://www.openclinica.com/community-edition-open-source-edc-2/.
[22] Further information available at: https://wirvsvirus.org/.
[23] Further information available at: https://covidhackgr.gov.gr/.
[24] Further information available at: https://www.euvsvirus.org/.

2 Overview of open source contributions

The swift response of the open source community helped citizens, researchers and health practitioners alike to navigate the unparalleled conditions brought about by the pandemic. Having a closer look at the sectors covered by the present report, the OSS within the DRC targeted at the health or education sectors has been further analysed. Amongst these solutions, 80% are aimed at supporting the health response to the COVID-19 crisis by serving different purposes, ranging from assisting citizens with self-diagnosis tools like the covid-bot[25] and supporting academic and medical research by publishing epidemic modelling software, to providing medical services through the release of hospital management software or COVID-19-specific medical imaging software. Education-related OSS, which accounts for 20% of the solutions considered in the scope of this report, supported the continuous delivery of educational services throughout the lockdowns, e.g. with solutions supporting education professionals organising learning activities and delivering virtual classes.

Four types of stakeholders that developed open source solutions in response to the COVID-19 pandemic were identified from the sample, namely associations, individuals, private companies and public administrations. By analysing stakeholder contributions, the identified solution clusters showed that public administrations were more likely to engage with OSS in comparison to other stakeholders, as shown in Figure 2 Distribution of solutions per type of stakeholder group. Each cluster is broken down in the following sections.

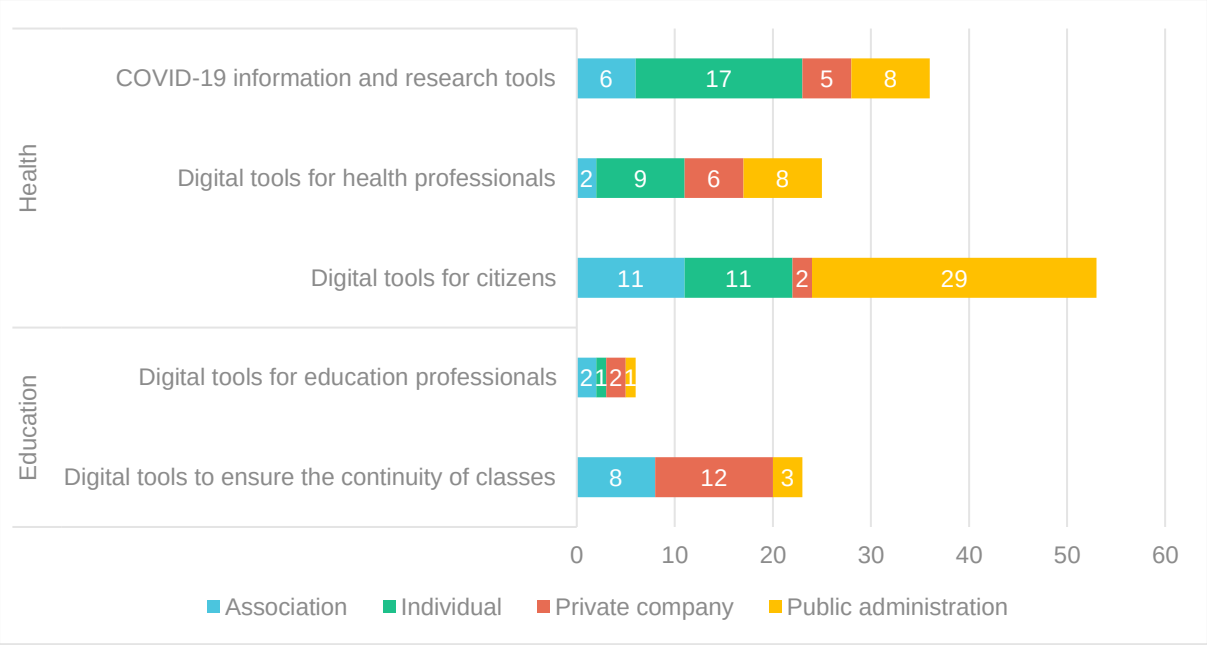


Figure 2 Distribution of solutions per type of stakeholder group

Source: analysis performed by Wavestone using data from the DRC collection, June 2021.

Even though public administrations were identified as the owners of over a third of all sampled solutions, their involvement proved to be heterogeneous across the two sectors. While public administrations were the primary contributors to health-related solutions, developing 39% of those sampled, their contribution

[25] Further information available at: https://www.covidbot.fr/.

to education-related solutions was smaller, representing only 16% of the sampled solutions that were developed by public administrations. Public administrations developed a large number of contact-tracing apps, COVID-19 information portals as well as testing management software. For education, however, private companies represented the majority of contributors, owning 48% of the sampled education solutions. This could be explained by the fact that educational purposes are supported by very versatile OSS; for instance, video conferencing tools may not have been designed specifically for teaching but proved useful in ensuring the continuity of educational services. Examples of education solutions include communication tools to facilitate exchange between teachers, parents and pupils, learning management systems (LMS) and web-conferencing solutions.

This variance in public sector engagement with OSS also reflects the nature of the COVID-19 crisis, as the strain on healthcare systems proved to be more urgent than that on education systems across the EU and beyond. Although the closure of schools and the shift to distance learning increased reliance on digital tools, the efforts of public administrations, and more broadly of the open source community, appear not to have been focused on the development of new education solutions but rather on the customisation of existing ones. This can be explained by an extensive pre-existing pool of education-related solutions, both open source and proprietary, available to EU public administrations prior to the COVID-19 crisis, which then saw an increased adoption following the onset of the pandemic. For example, the project and prototype for the Austrian solution Eduvidual[26], first launched in 2016, observed a ten-fold increase in users after the beginning of the Austrian lockdown, with a total of 6 million unique visitors in the entire year of 2020.

Overview of the OSS available to help the education sector

The delivery of remote education was sustained by a wide range of open source solutions that respond to the different needs of teachers, students and parents. Their prompt availability and software stability led to high adoption across the board, with some schools and universities opting to combine various solutions to ensure that all learning activities would be covered. However, public administrations with a lower level of awareness of OSS tended to turn to well-known off-the-shelf solutions[27].

[26] Further information available at: https://www.eduvidual.at/local/eduvidual/pages/login.php.
[27] Off-the-shelf solutions are understood as proprietary, ready-made software which may be customised after the purchase of the product.

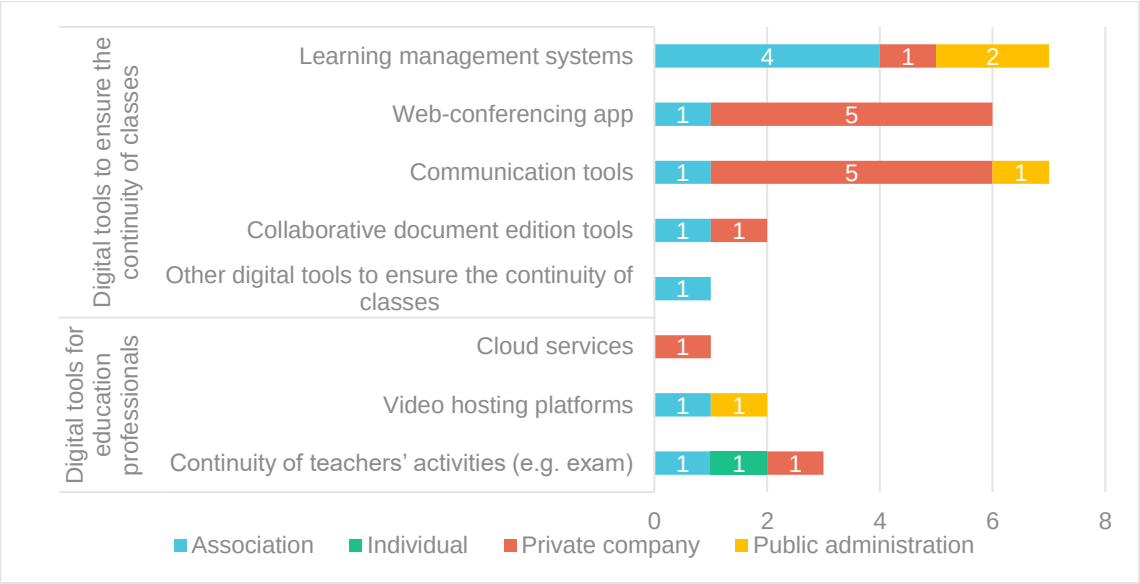


Figure 3 Breakdown of solutions for the education sector

Source: analysis performed by Wavestone using data from the DRC collection, June 2021.

The sampled solutions comprise several types of OSS supporting the education sector. Their distribution is detailed in Figure 3, showing that LMSs[28] and communication enablers (i.e. web-conferencing apps and other communication tools) were the primary open source solutions adopted to support the continuity of school activities. LMS solutions appear to be key enablers for the continuation of education services, given that they provide an all-in-one access to educational content. Aside from LMSs, the sampled solutions also include communication tools allowing teachers to exchange information with parents and students alike, for which private companies were the primary contributors. The major involvement of private companies in these types of solutions can be explained by the high horizontal demand for online communication tools, both prior to and during the COVID-19 pandemic.

Overall, numerous EU countries relied on open source solutions to support schools and universities in the organisation of online classes. In Germany, the State of Baden-Württemberg listed Moodle's[29] LMS in its collection of online tools for digital teaching. It also provided information on the number of schools which adopted the solution in the region as well as supporting documents for teachers on how to use it. Similarly, the University of Ruse in Bulgaria adopted the BigBlueButton[30] software to allow lecturers to organise online classes. In light of the popularity of the solution amongst the lecturers, the University chose to install it on its IT servers. Finally, in Poland some primary schools introduced the video conferencing software Jitsi Meet[31] to organise meetings[32].

[28] Learning management systems (LMS) consist of platforms that teachers can use to provide courses, manage classes, communicate and track students' performance.
[29] Further information available at: https://moodle.org/.
[30] Further information available at: https://bigbluebutton.org/.
[31] Further information available at: https://jitsi.org/.
[32] Further information available at: https://www.who.int/publications/i/item/contact-tracing-in-the-context-of-covid-19.

Eduvidual

This case study was prepared with the kind input of Mag. Robert Schrenk from the Austrian Ministry of Education, Science and Research

What is Eduvidual?

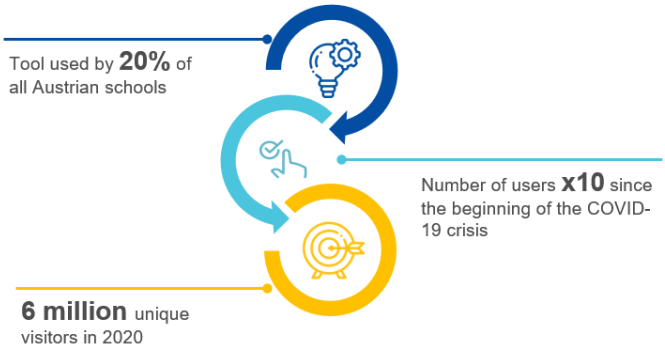
Eduvidual is a Moodle-based educational platform developed by the Austrian Federal Ministry of Education, Science and Research. Highly customisable, the platform provides a unique template that can be tailored to the needs of each user through plug-ins. The customisation of Eduvidual can include additional activities (e.g. lessons, assignments, discussions and quizzes) as well as an enhanced interface to increase the user-friendliness.

Through Eduvidual, teachers can make use of a shared pedagogic space to publish open educational resources (OER) made available to the whole community such as Moodle tutorials, classes and introductory courses. A helpdesk is automatically at the disposal of schools and users can avail of one-on-one sessions with the Eduvidual team.

Project timeline

- **2016**: kick-off with the non-profit association Digital Education Society
- **2017-2019**: pilot project overtaken by the Austrian Ministry of Education, Science and Research
- **2019-2020**: launch of and migration to the new learning platform
- **Autumn 2020**: introduction of a server cluster infrastructure, thus fostering the scalability of the platform

Key figures



A tool responding to the COVID-19 crisis

Eduvidual is the result of a pilot project started in 2016 by the non-profit association *Digitale Bildungsgesellschaft* (Digital Education Society) and taken over by the Austrian Ministry of Education, Science and Research in 2017. Following the closure of Austrian schools during the first wave of the COVID-19 pandemic, this stable LMS was leveraged by public administrations to provide a digital solution to help teachers give lessons remotely. In light of the success of the platform, a server cluster infrastructure was introduced in autumn 2020 to enhance its scalability.

The high level of customisability of Eduvidual ensured that the solution could respond to the needs of education professionals during the COVID-19 pandemic. Consequently, the Eduvidual team focused on developing extensions and plug-ins for the platform. For this task, the team received the help of the vast Moodle community, including the Austrian association, Academic Moodle Cooperation. The use of GitHub also enabled the team to exchange with developers around the world to further improve Eduvidual.

Apps.education

This case study was prepared with the kind input of Mr Jean-Marc Merriaux and Mr Laurent Le Prieur from the French Ministry of Education, Youth and Sport

What is Apps.education?

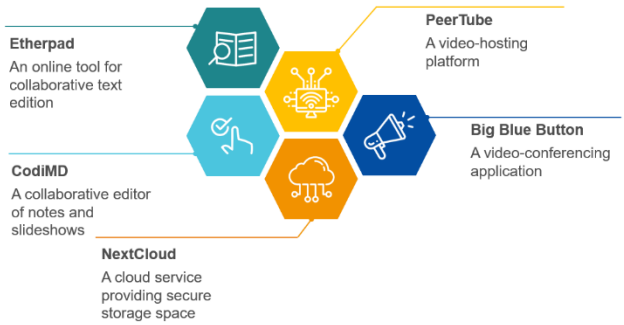
The Apps.education.fr portal is the national catalogue of educational digital services, co-developed by the French Ministry of Education, Youth and Sport, and the regional education authorities (*académies*) to provide services to education professionals. Mostly open source, the selected digital services are simple to set up, have already been used in education and are available on a large scale. The Apps.education features enable video publication, document sharing and video conferencing among others.

Following a model of pooled resources, the different regional education authorities operate a service as a single centre of expertise for the benefit of the whole country by providing governance of the service, ensuring the maintenance of operational conditions, and offering user support. The pool of digital solutions is coordinated by the central administration, which ensures the involvement of end users of Apps.education in the choice of applications to be included in the catalogue.

Key figures

- 35 000 accounts created
- 6.5 million files shared via NextCloud
- 35 000 videos uploaded on PeerTube
- 2 million views of PeerTube videos
- 30 000 BigBlueButton accounts
- 70 000 daily connections
- Between 3 000 and 5 000 collaborative essays per day on CodiMD and Etherpad

Open source software available in Apps.education



A tool responding to the COVID-19 crisis

Apps.education is the landmark project of an initiative launched in 2018 by the Directorate of Digital Education (DNE) within the French Ministry of Education, Youth and Sports to increase the availability of digital tools for education professionals. The COVID-19 pandemic and the subsequent closure of schools in France in March 2020 pushed the Ministry to accelerate the launch of the solution. The development of the platform, which was supposed to take several months, was finalised in eight days to swiftly provide a national catalogue of digital solutions to French teachers.

The strong OSS culture of the Ministry, both within the central administration and at the local level, facilitated the development and implementation of Apps.education in a short timespan.

Overview of the OSS available to help the health sector

Citizens and medical professionals have been supplied with numerous solutions, with innovative new features, that have helped combat the spread of the pandemic. To facilitate the development of health-related solutions, the open source community benefited from the support of the open science community. This community aims to make scientific research accessible to all and encourage people to adopt open science practices. The urgency and global impact of the pandemic inspired researchers around the world to share datasets on the virus and its spread. This movement, aligned with open source principles, contributed to the acceleration of research on the COVID-19 vaccine. The full genome of the COVID-19 virus was published, just one month after the first patient was admitted into a Wuhan hospital, as an open-access publication in the medical journal The Lancet[33].

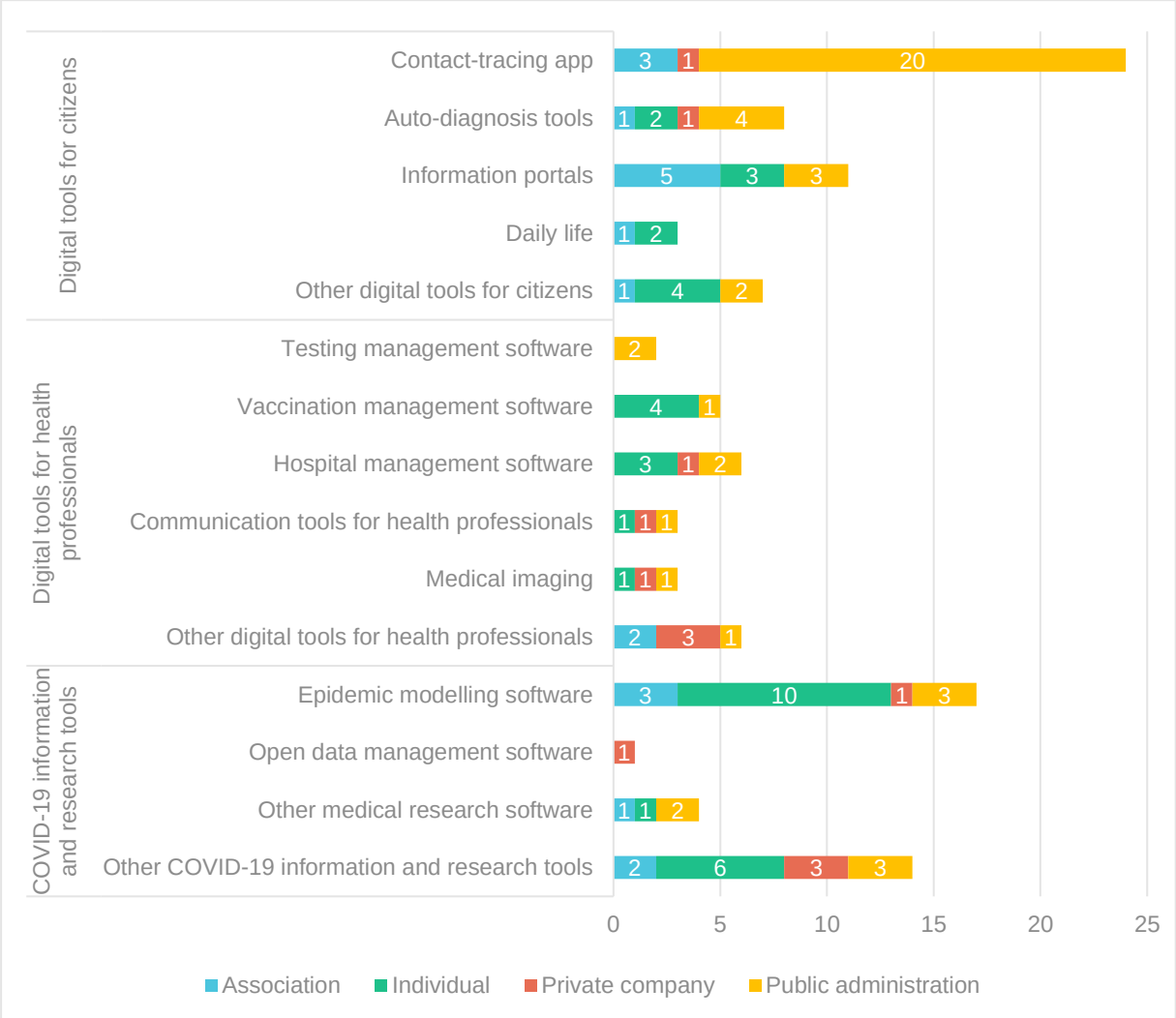


Figure 4 Breakdown of solutions for the health sector

Source: analysis performed by Wavestone using data from the DRC collection, June 2021.

[33] Organisation for Economic Co-operation and Development, *Why open science is critical to combatting COVID-19*, 2020. Retrieved at: https://www.oecd.org/coronavirus/policy-responses/why-open-science-is-critical-to-combatting-covid-19-cd6ab2f9/.

The breakdown of OSS supporting the **health** sector in Figure 4 reveals that, amongst the sampled solutions, a majority of stakeholders focused on developing digital tools meant for citizens. A high number of contact-tracing solutions were developed across and beyond the EU, representing 20% of the sampled health-related solutions analysed in this report. Contact-tracing solutions are, in most cases, mobile applications that notify individuals who have been in contact with someone who tested positive for COVID-19[34]. 83% of the sampled open source contact-tracing solutions were developed by public organisations, through either in-house developments or outsourcing, to support the response to COVID-19. This high percentage shows that public administrations embraced open source principles and shared the developed solutions to support others in a joint global effort. One example of a **contact-tracing application** is the Spanish Radar Covid[35]. In case a user receives a positive diagnosis, the application anonymously notifies whoever has been in contact with the user. The Irish COVID Tracker[36] mobile application offers similar features to its Spanish counterpart, with an additional auto-diagnosis component that provides health advice to users based on self-assessed symptoms.

In addition to solutions designed for citizens, the open source community also joined forces to create solutions for health practitioners and researchers. OSS for **epidemic modelling** received a lot of contributions throughout the crisis, with a variety of solutions aimed at supporting the modelling of the COVID-19 virus and its spread. This category of OSS, unlike contact tracing and auto-diagnosis tools, saw higher engagement from individual developers rather than associations, private companies or public administrations. The novelty of these solutions sparked the interest of the open source community, which then became involved to ensure their openness and quality.

[34] Further information available at: https://www.who.int/publications/i/item/contact-tracing-in-the-context-of-covid-19.
[35] Further information available at: https://radarcovid.gob.es/home.
[36] Further information available at: https://covidtracker.gov.ie/.

COVID-19 rapid testing service

This case study was prepared with the kind input of Ms Marietta Le and Dr Daniel Szabo from the city of Budapest

What is the COVID-19 rapid testing service?

The COVID-19 rapid testing service is a solution developed by the city of Budapest to support the city's COVID-19 testing campaign. It serves as an online registration software and provides the required registration form to users who want to be tested.

The decision to use OSS helped speed up the development process and facilitated reuse by other Hungarian municipalities. In addition, the two testing periods (i.e. five days in December 2020 and ten days in February 2021) allowed the development team to add more functionalities, such as automatic cancellation of appointments, attendance checking and live reporting. Later updates to the software enabled to repurpose it as an appointment booking service for the municipality's customer service office.

Project timeline

- **End of 2020**: 3-week development sprint to release the software
- **December 2020**: 5-day testing campaign
- **January 2021**: release of the second version of the software
- **February 2021**: 10-day testing campaign
- **From March 2021**: repurposing of the solution as an appointment booking service for the municipality's customer service office

Features of the COVID-19 rapid testing software

A tool responding to the COVID-19 crisis

The development of the rapid testing service software was the city of Budapest's first experience with in-house developed OSS. The city had started to engage with open source only shortly before, following the collaboration with the city of Paris in the Lutece project on participatory budgeting. The urgency of the COVID-19 crisis and the lack of existing software for this purpose influenced the decision to develop the COVID-19 rapid testing service as OSS.

The project received positive feedback from both citizens and the Hungarian media, representing a successful initiative that led to the increased engagement of the city of Budapest with OSS. The software counted 27 000 users during the December 2020 COVID-19 testing campaign and 43 000 users during the February 2021 testing campaign.

COVID Tracker

This case study was prepared with the kind input of Mr Gar Mac Críosta from the Health Service Executive

What is the COVID Tracker?

The COVID Tracker is a contact-tracing application created by the Health Service Executive and the Department of Health of Ireland, initially developed to notify users of COVID-19 exposure. Additional functionalities were integrated into the application at a later stage, such as data on the COVID-19 crisis in Ireland (e.g. the number of cases), a log of symptoms and voluntary phone registration to enable users to be easily contacted by health authorities in the event of a close contact alert.

The development of the COVID Tracker involved different public administrations and volunteers around the world, facilitated by the collaboration with the Decentralized Privacy-Preserving Proximity Tracing (DP^3T) and the Linux Foundation Public Health OSS communities. The community members included epidemiologists who shared their knowledge not just on open source development, but also on pandemic-related data exchange, for instance.

Key figures

- 1.3 million users (40% of all potential Irish users)
- 50 000 reported positive tests
- 32 000 users identified as close contacts
- Average of 200 000 active users at any given time

Features of the COVID Tracker Ireland App

A tool responding to the COVID-19 crisis

The development team of the COVID Tracker reaped the benefits of open source collaboration by involving participants beyond the core team of architects, namely research teams, external developers and developers from public administrations such as the Health Service Executive and the Department of Public Expenditure and Reform.

This collaboration allowed the COVID Tracker team to provide a digital solution to Irish citizens in a short timespan. With multiple teams running in parallel for eight weeks, the development phase was reduced to 100 days. The interoperability of the application with its Northern Irish sister solution was implemented in August 2020, followed by interoperability with other EU Member States' applications in October 2020, thus reinforcing the combat against the spread of the virus at EU level.

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The analysis of a sample of open source solutions supporting the digital response to the COVID-19 pandemic in the health and education sectors shows that open source was leveraged to limit the spread of COVID-19, support healthcare systems and ensure the continuous delivery of educational services. The education sector, which already had ties with the open source community, continued to build on existing open source solutions throughout the COVID-19 pandemic. However, in the health sector open source was an enabler for the development of innovative solutions, notably in the case of contact-tracing applications to combat chains of transmission and limit the spread of the virus. The success of these open source solutions can be explained by the advantages they offer to public administrations in a time of crisis, as detailed in Section 0.

3 Advantages of open source software in response to the COVID-19 crisis

Faced with the pressing need to ensure the continuity of public services through digital means as a response to the COVID-19 pandemic, EU public administrations had the opportunity to make the most of the involvement of the open source community that was explored in Section 1. The use of open source enabled public administrations to put in place a more efficient software development process for COVID-19-related solutions, draw the benefits of interoperability, foster collaboration and ensure the user-centricity of digital solutions. In addition, the open source community's familiarity with remote and open working methods helped to build and maintain smooth, collaborative development processes around COVID-19 solutions. This section explores the advantages offered by the use of OSS to respond efficiently to the pandemic.

Allowing an efficient software development process

By turning to open source solutions, public administrations were able to implement a more efficient software development process, helping them to gain precious time in the urgent provision of COVID-19-related digital solutions. The short time to market of open source solutions was made possible by the **reuse of open source components**, particularly noteworthy in the case of contact-tracing applications. The Singaporean government was the first to release its contact-tracing protocol Blue Trace[37] as open source, which has since then been reused by the Australian government for the release of its COVIDSAFE solution[38]. The model of Singapore was closely followed by other governments, such as Israel's with the release of The Shield[39]. The examples of the Singaporean and Israeli governments paved the way for publishing European contact-tracing apps as open source. The open publication of code bases enabled other governments to reuse existing solutions or OSS components, including in areas other than contact-tracing applications. In the case of Apps.edu[40], an OSS platform which offers a range of digital solutions to facilitate remote education for French teachers, the development phase spanned a mere eight days thanks to the reuse of open source components.

By reusing existing components or code bases, the development of additional modules or the use of a forked version of an open source solution is **less costly**. A salient example of cost reductions brought about by the reuse of COVID-19-related solutions is the Belgian government's fork of the German COVID-19 tracing app Corona-Warn[41], which cost around EUR 20 million to develop. Its Belgian sister solution, Coronalert[42], was released for a fraction of the cost, reported by different media sources as being below EUR 1 million.[43] These cost savings contributed to the democratisation of access to much-needed digital solutions in response to the COVID-19 pandemic, although the total cost of ownership[44]

[37] Further information available at: https://bluetrace.io/.
[38] Further information available at: https://covidsafe.gov.au/.
[39] Further information available at: https://govextra.gov.il/ministry-of-health/hamagen-app/download-en/.
[40] Further information available at: https://apps.education.fr/.
[41] Further information available at: https://www.coronawarn.app/.
[42] Further information available at: https://coronalert.be/en/.
[43] Open Source Observatory, *Belgium saved 85% of development effort by forking the German COVID-19 app,* November 2020. Retrieved at: https://joinup.ec.europa.eu/collection/open-source-observatory-osor/news/belgium-forked-its-covid-19-app.
[44] Measure of all the costs of identifying, acquiring, installing and operating software as well as the exit costs incurred in migrating away from the software.

of a solution should be taken into account[45]. In the case of COVID-19 OSS solutions, the costs associated with the potential long-term use of the solutions need to be assessed.

Reaping the benefits of interoperability

Open source and the use of open standards contributed to the development of an efficient framework to share and reuse digital solutions adapted to public administrations' needs during the COVID-19 crisis. The use of common standards enhanced interoperability, which in turn boosted the efficiency of the newly developed solutions and opened the door to cross-border collaboration, by allowing public administrations to exchange information and software electronically in ways that are understood by all parties.

Open source facilitated the **reuse of solutions** within and across countries, given that many public administrations in Europe faced similar problems and had similar digital needs. Given the high number of requests from other public administrations wanting to reuse a solution, public entities had to rely on open source communities to support the uptake of their OSS. An example of this collaboration between public administrations and OSS communities is the case of Eduvidual: the core development team received help from the Moodle community for the development of new features and the publication of documentation.

The success of health-related OSS during the COVID-19 crisis can also be explained by the **transparency** of the code, providing reassurance to users, particularly following the data privacy concerns sparked by the release of contact-tracing applications. OSS also benefited from external scrutiny of a much larger community to check the code base and prevent security breaches. In the case of the Covid-SAFE app[46] that was developed by the non-profit organisation Citizen Next[47] for the Romanian public sector, a specific audit on data privacy was carried out by external experts. This procedure aimed to ensure that the solution met the highest security standards before being released on a large scale.

Finally, in the field of healthcare, the development of COVID-19-related solutions was for many public administrations the first engagement with open source. In the case of the software supporting the COVID-19 rapid testing service of the city of Budapest, the decision to use open source was taken to **lighten the administrative burden** and foster the uptake of the solution by other Hungarian municipalities. Although the choice of open source required the adaptation of internal processes, in particular with regard to the awareness of open source licences' requirements within legal and public procurement departments, the solution was effectively reused by the 9th district of Budapest.

Ensuring the development of fit-for-purpose solutions

Another characteristic of OSS greatly appreciated by public administrations is that, unlike most proprietary solutions, whose use is linked to a number of downloads or active users, open source solutions offer greater **scalability**. This advantage was underlined as a key enabler in the education sector, where large-scale deployment of solutions is required. For instance, the number of Eduvidual users saw a ten-fold increase from the start of the lockdown measures, with more than 28% of all

[45] Shaikh, M. and Cornford, T., *Total cost of ownership of open source software: a report for the UK Cabinet Office supported by OpenForum Europe*, 2011. Retrieved at: http://eprints.lse.ac.uk/39826/1/Total_cost_of_ownership_of_open_source_software_(LSERO).pdf.
[46] Further information available at: https://citizennext.ro/proiecte/covid-safe-frontiera.
[47] Further information available at: https://citizennext.ro/.

Austrian students using the solution. Similarly, the Apps.edu portal[48] was made available to 1.2 million public agents of the French Ministry of Education, Youth and Sports.

Additionally, the **adaptability of OSS** to emerging needs constitutes another advantage of such technologies in times of crisis. Drawing on the benefits of long-term collaboration with open source communities working on education-related solutions, public administrations had the opportunity to choose from a large catalogue of solutions. The availability of solutions is reflected in this report's case studies, as both platforms (i.e. Apps.edu and Eduvidual) existed or were planned to be released prior to the COVID-19 pandemic and proved to be very useful digital solutions for facilitating remote education. For example, the Apps.edu platform offers a wide range of open source solutions and services, including EtherPad[49], CodiMD[50], NextCloud[51], PeerTube[52] and BigBlueButton[53].

Leveraging the scalability and the adaptability of OSS, public administrations were in a position to develop and/or adapt solutions tailoring them to their needs, and to deploy them nationwide in a short time span. These advantages were of the utmost importance in response to the sudden disruption of public services, including the closure of schools in the EU.

Making the most of open source collaboration

Another element contributing to the reduced time to market of open source solutions is the collaboration amongst public administrations themselves as well as with open source communities. OSS collaboration can take many forms, ranging from contributing to the source code through pull requests to sharing good practices regarding licensing. The visibility of open source solutions has led to the sharing of implicit values, thus increasing the potential and effectiveness of open source collaboration. With regard to the education and health sectors' response to the COVID-19 pandemic, two different situations can be observed.

On the one hand, the education sector has been a long-time contributor to and user of open source solutions. Some open source communities working on educational solutions have existed for many years, such as the Moodle community, that was created in 2002[54]. The **well-established collaboration** between open source communities, public administrations and academia in this field facilitated the adoption and/or adaptation of existing OSS in response to the needs arising from the COVID-19 pandemic, as long-standing communication channels between various stakeholders were already in place. Furthermore, some EU central administrations and academia have a good understanding of OSS and its benefits. For example, a department dedicated to the use of OSS has been active within the French Ministry of Education for more than 20 years. These close ties with open source communities have been leveraged to tailor open source solutions to the needs of the education sector and/or obtain user support. Given that collaboration is a key value of open source, OSS proved to be a useful vector not only to ensure the continuity of education services but also to foster **educational content-sharing**. Throughout the COVID-19 crisis, teachers were able to share their material on LMSs such as Moodle or Eduvidual, or video-sharing platforms such as PeerTube[55].

[48] Further information available at: https://apps.education.fr/.
[49] Further information available at: https://etherpad.org/.
[50] Further information available at: https://codimd.web.cern.ch/.
[51] Further information available at: https://nextcloud.com/.
[52] Further information available at: https://joinpeertube.org/.
[53] Further information available at: https://bigbluebutton.org/.
[54] Further information available at : https://moodle.org/.
[55] Further information available at: https://joinpeertube.org/.

In contrast to the education sector, where numerous open source solutions had been in place for many years, the development of open source solutions in the health sector was characterised by the emergence of new solutions. For many EU public administrations, the COVID-19 crisis marked their first engagement with open source in the domain of health. In the case of the Irish COVID Tracker[56], the developing team received many requests to reuse the solution. To facilitate the management of those requests, the COVID Tracker app team partnered with the Linux Foundation Public Health[57]. This community supported the core development team by providing documentation and technical support to developers in other countries. The COVID Tracker app team also got in contact with advisors from the Linux Foundation for suggestions on tools facilitating the reuse of OSS. The open development and the collaboration with multiple contributors also enabled the COVID Tracker team to develop the solution from scratch within 100 days.

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The numerous advantages brought by the use of OSS proved to improve the digital resilience of public administrations in times of crisis. The faster development process as well as the collaboration with open source communities enabled public administrations to provide citizens and businesses with digital solutions in a short timespan. By leveraging the benefits of OSS in terms of interoperability and customisability, public administrations were also able to offer fit-for-purpose and transparent OSS, thus fostering user trust and the uptake of these digital solutions. To make the most of OSS, this research identified a series of good practices related to COVID-19 readiness, which are explored in more detail in Section 4.

[56] Further information available at: https://covidtracker.ie/.
[57] Further information available at: https://www.lfph.io/.

4 Lessons learnt from the factors influencing public administrations' COVID-19 readiness for the use of OSS

A set of enabling factors linked to the governance model, human capital and technology capabilities of public administrations enabled them to benefit from the advantages of open source during the COVID-19 crisis, especially in the health and education sectors. This report reflects on the lessons learnt by public administrations with regard to these enabling factors and presents the good practices emerging from them through three different clusters.

Establishing a favourable governance

For EU public administrations to quickly leverage OSS in response to the COVID-19 crisis, a **favourable governance** had to be established to prevent organisational setbacks and facilitate the rapid development of new solutions. Such governance improves digital resilience and allows for an efficient contribution of individuals and/or organisations working on OSS.

 **Political and hierarchical support**	Strong political and hierarchical support for the development and implementation of OSS accelerates software adoption and facilitates the approval of funding mechanisms in the public sector. For instance, the development of the Irish COVID Tracker app was facilitated by the support of high-ranking public officials. Political support also fostered positive collaboration between different public administrations such as the Health Service Executive and the Department of Health, which engaged in open daily collaboration and communication throughout the COVID-19 pandemic.
 **Collaboration between public administrations**	The collaboration and communication channels established between public administrations help to increase the awareness and understanding of the collaborative benefits of open source. In the context of COVID-19, this served as an accelerator for the deployment of OSS by providing increased resources and expertise to administrations launching open source solutions. In the case of the Apps.edu portal, the Directorate of Digital Education of the French Ministry of Education, Youth and Sports relied on a model of pooled resources, working with the regional education administrations (*académies*) to provide a wider range of services. Each regional administration therefore operates as a single centre of expertise for the benefit of others, providing services governance, operational maintenance and user support. The offer is coordinated at national level, via a governance system involving several Ministry directorates and some end users.

Collaboration with open source communities	To assist in the rapid development of solutions in response to the COVID-19 crisis and make the most of OSS, some public administrations collaborated with open source communities to benefit from their targeted expertise in such projects. The team developing the COVID Tracker in Ireland benefited from collaboration with the Linux Foundation Public Health community by receiving insights on how other countries were approaching the crisis and similar projects, as well as on how to tackle some of the challenges encountered.
Software development methodologies	The successful management of open source projects requires adequate software development methodologies that foster an agile organisation between developers. This proved important during the COVID-19 crisis, as such methodologies enable the coordination of all involved parties in a short time frame. This factor also facilitates an iterative development process focussing on testing to quickly launch a functional software. In Hungary, the development of OSS to enable rapid COVID-19 testing services relied on agile service design methodologies. These ensured that the software was tested multiple times and feedback was gathered from users to prevent any potential malfunctions and continuously enhance the software.
Budget availability	Budget is crucial to ensure successful open source development through the procurement of adequate human and technical resources. The crisis added a financial challenge, as a rapid response required skilled personnel and quickly available budget. The use of public funding dedicated to crisis management or special funds allocated to the response to the COVID-19 pandemic allowed public administrations to handle the costs associated with developing or reusing an open source solution. For example, in the cases of the Hungarian rapid testing service and the Irish COVID Tracker, both governments released additional public funding for the development of the OSS solutions.

Fostering human capital skills

The set of digital skills available within public administrations can be a determining factor of their involvement with open source, as a lack of knowledge or skills can hinder the uptake of OSS. To respond to the unforeseen circumstances brought about by the COVID-19 pandemic, the development and delivery of OSS in a short timespan required some public administrations to rely on their internal capabilities, leverage different working methods and explore new project management processes.

Civil servants' digital skills	Having an elevated set of digital skills is deemed an enabling factor by all public administrations in the development of OSS. This is further emphasised in a time of crisis, when there is little time to hire new staff members or upskill through internal training schemes. Digital skills also reduce the reliance on lengthy public procurement processes. Over 20 years, the French Ministry of Education, Youth and Sports has gathered a significant number of digitally skilled civil servants through the Information Systems Department of the Academic Delegation for Digital Education. This gives the Ministry the human resources required to tailor OSS to its needs. Additionally, the courses offered to public administrations through the Red Hat Academy[58] saw an increase in their enrolment during the COVID-19 pandemic, particularly on the topic of skills development in the public sector.
Capacity to innovate	Open source development is inherently collaborative and aims to draw from open contributions to provide an innovative solution to end users. Therefore, the ability to innovate and tailor the end product to users' needs is an important factor for a successful OSS. In the context of the COVID-19 pandemic, unprecedented challenges required public administrations to quickly adapt their solutions to new demands. The first-time development of an open source solution within the city of Budapest sparked innovation to the benefit of the municipality. The rapid testing service made available brought a new and more efficient end-to-end process both for citizens, simplifying the booking of their testing appointments, and for the public administration, enabling the live reporting of the testing figures to the municipality's operational unit.
Knowledge of open source	Previous experience and understanding of the inner workings of open source ensures the readiness of project teams to contribute to and reuse open source solutions. In the case of Eduvidual, having a team that understood the particularities of working with open source enabled to capitalise on Moodle's high level of customisability. This helped expand the Eduvidual platform and offer schools the possibility to tailor the platform to their needs.
Engagement with users	The use of open platforms to exchange information between OSS contributors and end users is a common component of open source development. For public administrations already familiar with such platforms, the global impact of the COVID-19 pandemic led to an increased focus on their needs and a higher number of contributors interested in providing support services for solutions.

[58] The Red Hat Academy is a training and skills academic programme developed by Red Hat for open source upskilling.

	For the French solution Apps.Edu, the establishment of a dedicated online space for discussions facilitated the dialogue between the different project teams and end users, helping to boost the development and maintenance of the solution throughout the pandemic.

Relying on suitable tools and technologies

The COVID-19 crisis has accelerated the adoption of technologies and the digitisation of governments. To benefit fully from all the advantages of OSS and improve the features and popularity of their own COVID-19 solutions, public administrations made the most of the different OSS **tools and technologies** to increase the stability and openness of their solutions.

 **Use of open source repositories**	Using OSS repositories is part of the open source development model and can help coordinate and track the efforts of contributors. Public administrations indicated that this factor was very important in their experiences with OSS during the COVID-19 pandemic, allowing for agile management of the different contributors to the solutions. In the case of Ireland's COVID Tracker, using various repositories helped extend the outreach of the solution and foster collaboration.
 **Choice of the open source licence**	The choice of the open source licence determines how easily public administrations can integrate external contributions, protect the openness of the code and foster the reuse of their solutions. For some public administrations, the COVID-19 pandemic was their first experience in developing an open source solution. They quickly learned that an analysis of the different open licence requirements was an essential step to avoid being locked into a specific publisher. The core development team of the Irish COVID Tracker changed the licence on the advice of the Linux Foundation to protect the openness of the code, switching from an MIT licence to an Apache 2.0.
 **Software documentation**	The availability of software documentation benefited the work of public administrations both as maintainers and reusers of solutions. It helps reusers and contributors to understand the objectives of the software, its mechanics and the requirements to better use the code. In the context of the COVID-19 pandemic, the publication of software documentation enabled much-needed collaboration on digital solutions worldwide, accelerating their development and increasing their quality. The development of Eduvidual required leveraging extensively on the resources made available by the Moodle community, which introduced the team to the software and tools at their disposal. Later, to help ease the reuse of the solutions by other administrations and promote the improvement of the Eduvidual platform through contributions, the team published their software documentation covering their entire development process.

Solution's robustness	For platforms and mobile applications to provide a stable user experience, a robust server infrastructure, regular updates and the integration of emerging technologies can help solidify and scale up the solutions. In the case of the COVID-19 pandemic, these factors helped with the development of open source solutions. From the experience of the Apps.Edu and the rapid testing service teams, having engaged with an active community and dedicated time for testing and gathering user feedback contributed to the quality control process of the open source project.

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Public administrations had the opportunity to leverage the above-mentioned enablers to enhance their COVID-19 readiness, increase their digital resilience, and efficiently develop and/or deploy open source solutions.

5 Conclusion

The digital response to the COVID-19 pandemic benefited from a variety of contributions from the open source community, demonstrating its commitment and collaborative spirit. The results of this involvement are visible in the development of new solutions, notably in the health sector and in the support provided to public administrations in the provision of remote educational services.

The uptake of OSS by public administrations can be explained by the advantages offered by open source: faster development phase, greater interoperability, transparency, reduced costs and support from the open source community. Gathering the benefits of these advantages, many public administrations across the EU successfully released and/or used open source solutions to respond to the urgent needs of citizens, health practitioners, researchers, students and teachers.

Unfamiliarity with OSS made some public administrations doubt the degree of user support and software maintenance that might be offered in the long term. The uptake of OSS during the COVID-19 crisis was thus hindered by a lack of awareness of open source in the public sector, which led some public administrations to choose proprietary off-the-shelf software for their activities. However, to maximise the benefits of using OSS, other public administrations relied on several internal factors that contributed to their COVID-19 readiness, from governance and human capital to technology.

The COVID-19 pandemic accelerated the uptake of OSS by public administrations, many of which developed OSS for the first time. The availability and quality of OSS contributed to efforts to raise awareness on open source both amongst citizens and within public administrations, especially amongst civil servants with senior, decision-making positions. The successful use and reuse cases of OSS against the backdrop of the COVID-19 pandemic could set a precedent for future open source projects led by the public sector. It is hoped that these positive experiences will further encourage public administrations' adoption of and engagement with OSS.

> *"In the digital decade, open source will be a key element to achieve Europe's resilience and digital sovereignty",* Thierry Breton, Commissioner for the internal market