



# Large-scale EXecution for Industry & Society

## Deliverable D8.4

### Roadmap for the further development of the LEXIS Portal



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## GLOSSARY

ACRONYM	DESCRIPTION
REST	Representational State Transfer
AAI	Authentication and Authorization Infrastructure
CI/CD	Continuous Integration / Continuous Development

**TABLE OF PARTNERS**

ACRONYM	PARTNER
Avio Aero	GE AVIO SRL
Atos	BULL SAS
AWI	ALFRED WEGENER INSTITUT HELMHOLTZ ZENTRUM FUR POLAR UND MEERESFORSCHUNG
BLABS	BAYNCORE LABS LIMITED
CEA	COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES
CIMA	CENTRO INTERNAZIONALE IN MONITORAGGIO AMBIENTALE - FONDAZIONE CIMA
CYC	CYCLOPS LABS GMBH
ECMWF	EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS
EURAXENT	MARC DERQUENNES
GFZ	HELMHOLTZ ZENTRUM POTSDAM DEUTSCHESGEOFORSCHUNGSZENTRUM GFZ
ICHEC	NATIONAL UNIVERSITY OF IRELAND GALWAY / Irish Centre for High-End Computing
IT4I	VYSOKA SKOLA BANSKA - TECHNICKA UNIVERZITA OSTRAVA / IT4Innovations National Supercomputing Centre
ITHACA	ASSOCIAZIONE ITHACA
LINKS	FONDAZIONE LINKS / ISTITUTO SUPERIORE MARIO BOELLA ISMB
LRZ	BAYERISCHE AKADEMIE DER WISSENSCHAFTEN / Leibniz Rechenzentrum der BAdW
NUM	NUMTECH
O24	OUTPOST 24 FRANCE
TESEO	TESEO SPA TECNOLOGIE E SISTEMI ELETTRONICI ED OTTICI

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## EXECUTIVE SUMMARY

LEXIS Portal is a crucial technology component which brings all the core capabilities of the LEXIS platform in a convenient, accessible format to the end users - European SMEs, industry, and research institutions. This deliverable sets the roadmap for further development of LEXIS Portal by open source community members, members of current LEXIS consortium, or by potential upcoming European project teams in the near future.

The LEXIS Portal has kept access control and security as its central development theme while providing access to LEXIS data management (see Deliverable D3.5 [1] and D3.6 [2]), workflow management (see Deliverable D4.4 [3]), and usage and cost tracking in a user-friendly manner via the web-portal (see for example Deliverable 3.4 [4]).

The feedback from LEXIS Pilots and LEXIS Open Call applications (details about LEXIS Open Call are described in Deliverables D9.4 [5] and D9.12 [6]) confirms the overall ease of use of the UI elements and also validates the theme and colour choices made by the implementation teams. While creation and execution of workflows were the most used features of the Portal, the survey respondents point out that dataset browsing and execution of certain workflows were also among the most difficult features to grasp.

Among the missing capabilities identified internally and based on survey participants, self-onboarding by a potential user organization features prominently. While several identified gaps were concerning usability aspects, such as auto refresh of workflow execution logs, and busy wait indications, etc. some gaps identified were operational in nature too. Inadequacy in Portal notification subsystem was one such gap. Minimization of latencies with some workflows, access to audit logs, improvement in access security via 2-factor authentication have been some of the prominent requests which provides ample hints in the future direction Portal components could take.

For quick onboarding of new development teams, this deliverable summarizes key tools used by WP8 engineering team, including discussion of some of the prominent open source libraries which have been used during the development phase of the LEXIS Portal.

# 1 INTRODUCTION

The current era we live in is the era of digitisation. Even physical artefacts such as large factory spaces are being digitized using concepts such as digital twinning. Massive advances are being made in the fields of AI, Big data, etc. All such innovations require tremendous compute power to support complex algorithms, real time communication needs, and in some cases strict timeliness requirements. European grid initiatives in the past have resulted in massive compute infrastructures set-up in various parts of Europe, but even today such compute facilities remain out of bounds for many private and commercial entities.

Commercial cloud providers, most successful ones being non-Europeans, have moved in quickly to fill in the gap created due to lack of accessibility of publicly funded HPC centres in Europe. LEXIS strives to address this very concern by creating tools and processes to allow easy access to European customers to excess capacity available within several large European HPC centres.

Although, LEXIS features and capabilities are accessible over RESTful APIs, experience with LEXIS Pilots show that the visual work-flow provided by the LEXIS Portal as a graphical user interface remains more popular mode of interaction with LEXIS capabilities.

The remainder of the deliverable is organized as follows - in Section 2, we quickly summarize the key capabilities of the LEXIS Portal, in Section 3, we describe the results of a brief survey conducted using LEXIS Pilots and LEXIS open call applicants, in Section 4 we present detailed gap-analysis in LEXIS Portal capabilities, and in Section 5 we present a viable plan for continued development of the Portal capabilities even beyond the official close of the LEXIS Project, in Section 6 we summarize the available resources, documentations and other developer guides which can speed up the independent developer community adoption / adaptation of a LEXIS Portal code-base.

# 2 SUMMARY OF KEY CAPABILITIES

The LEXIS Portal is a software component which provides an easy to use graphical user interface to the users in a secure, access controlled manner. The Portal makes use of the same RESTful APIs which is available to advanced users of the LEXIS stack. The key capabilities of the Portal are listed below, grouped by categories.

## 2.1 ACCESS CONTROL AND SECURITY

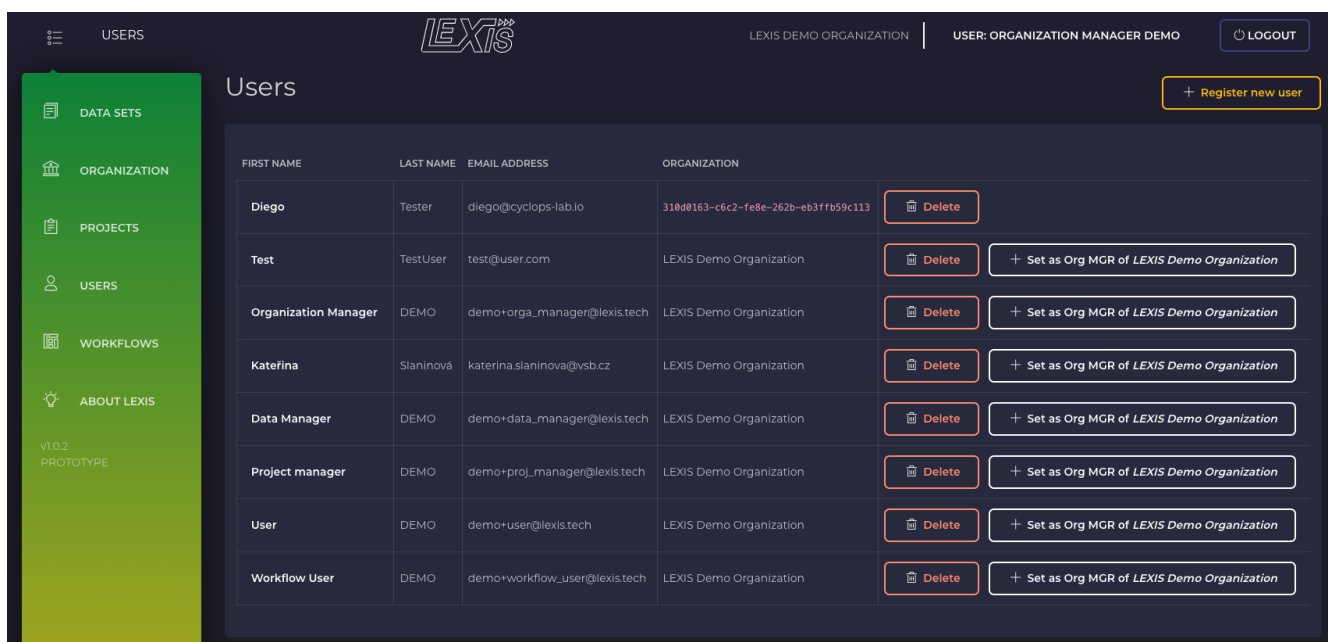


Figure 1 LEXIS Portal user and role management view for organization manager users

The LEXIS Portal has put great emphasis around security and secure access to data (see Figure 1). The Portal supports multiple roles and multiple organizations. Roles supported include organization manager, AAI manager, Project manager, Workflow user, Data set manager, etc. The Portal allows an Organization manager user to invite other users and also manage the associated role for the users in an organization.

## 2.2 DATASET MANAGEMENT CAPABILITY

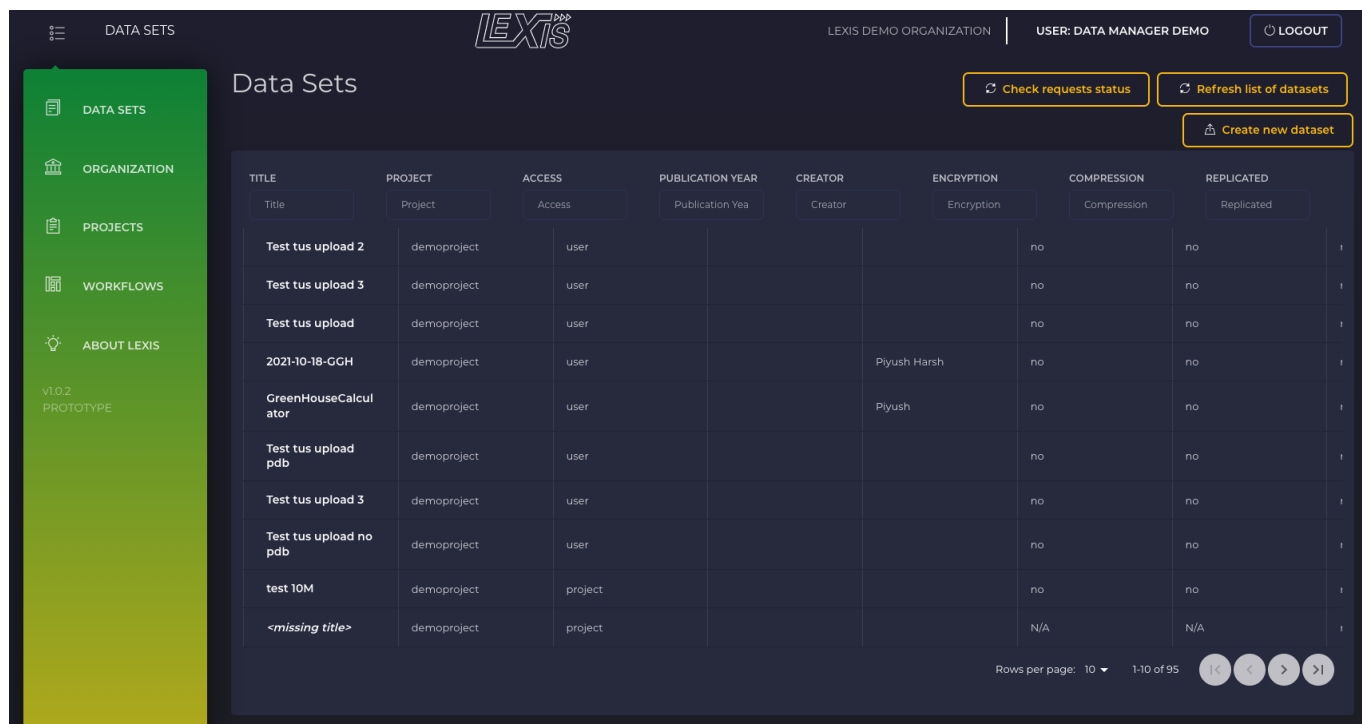


Figure 2 LEXIS Portal Data Management landing screen

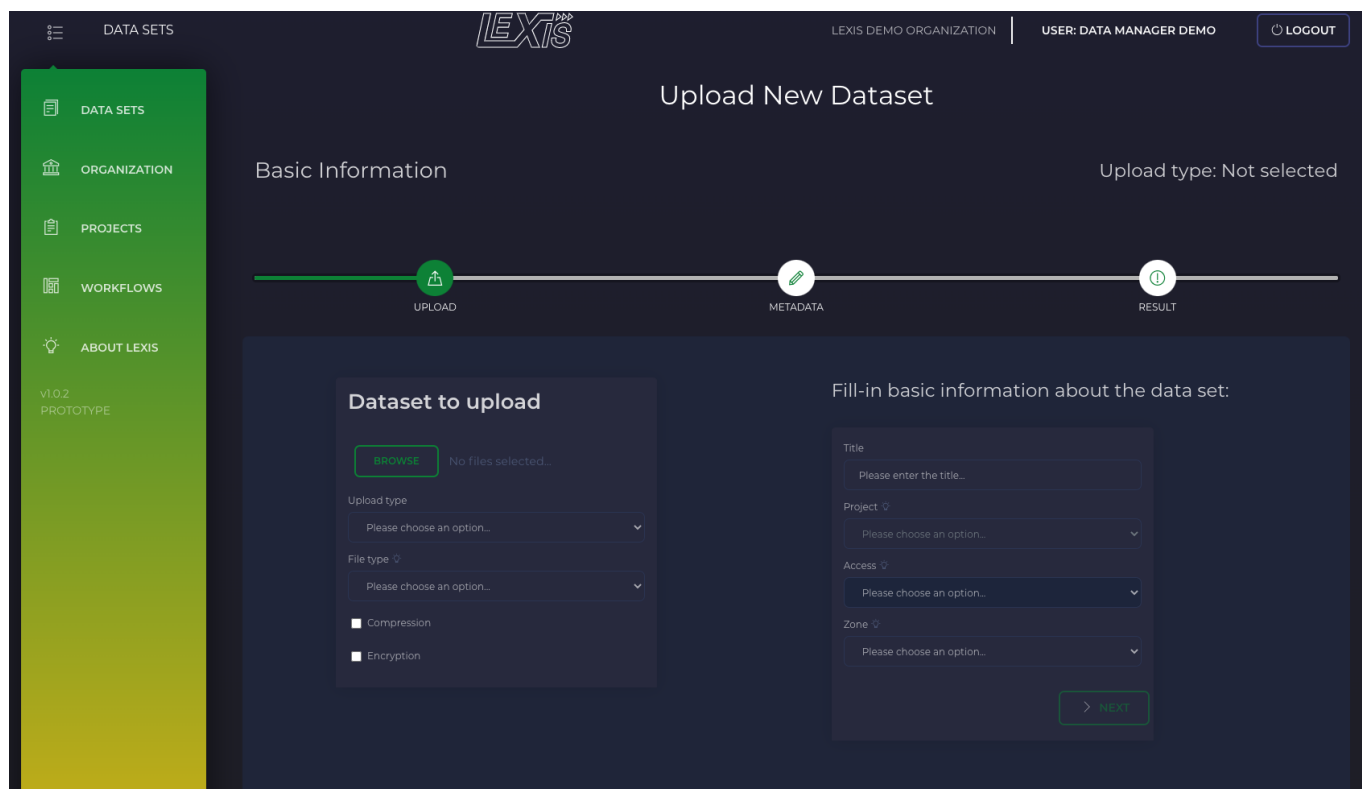


Figure 3 LEXIS Portal Data set creation screen

The LEXIS Portal allows a user with Data manager role to seamlessly manage large or small datasets. The metadata management is also supported as well as ability to manage the dataset visibility and scope (see Figure 2 and Figure 3).

### 2.3 WORKFLOW MANAGEMENT



Figure 4 Workflow execution progress monitoring

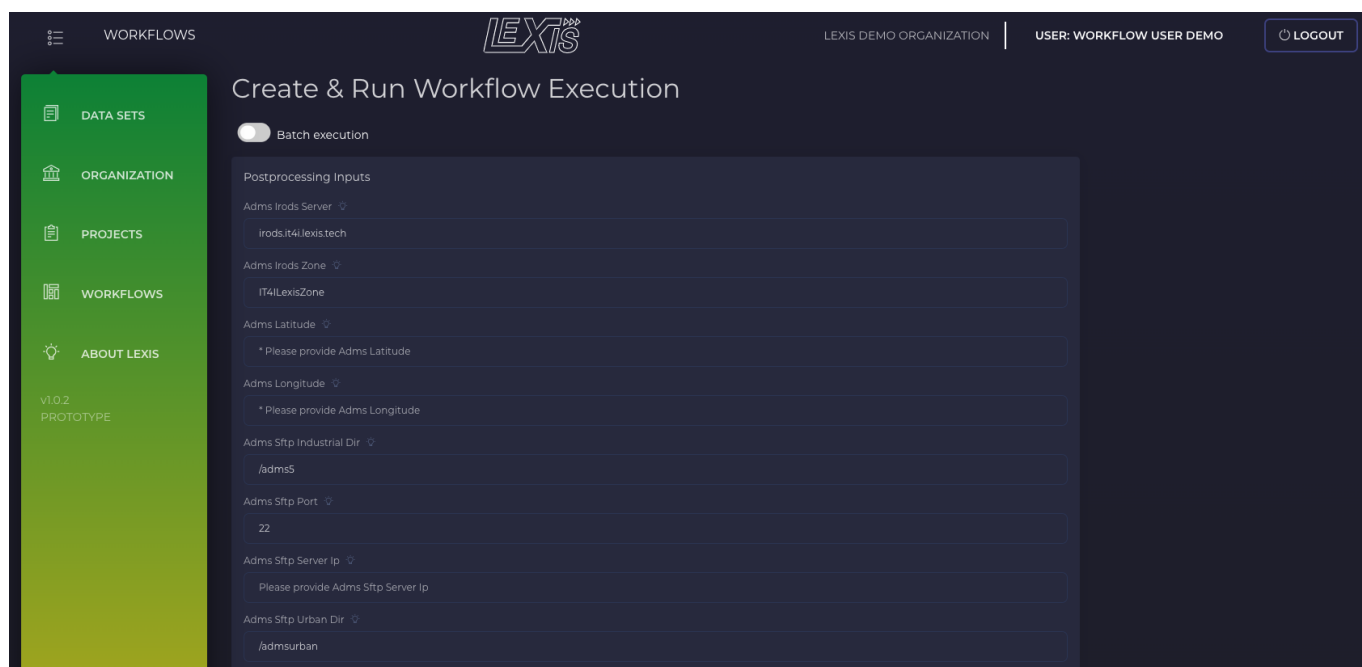


Figure 5 Workflow execution instantiation form

The LEXIS Portal has extensive support for workflow creation, and further management and monitoring of execution (see Figure 4 and Figure 5). It allows the user to work with existing templates, and even supports template creation via uploading of template files from local machine environment. Workflows can be scheduled as well as batch execution agenda can be created and managed via the Portal. The LEXIS Portal provides convenient ways for the post execution results to be accessed, the visualization of results - both 3d as well as 2d - is supported.

The Portal also supports editing of certain configuration files within the user browser to improve usability.



## 2.4 ACCOUNTING AND BILLING

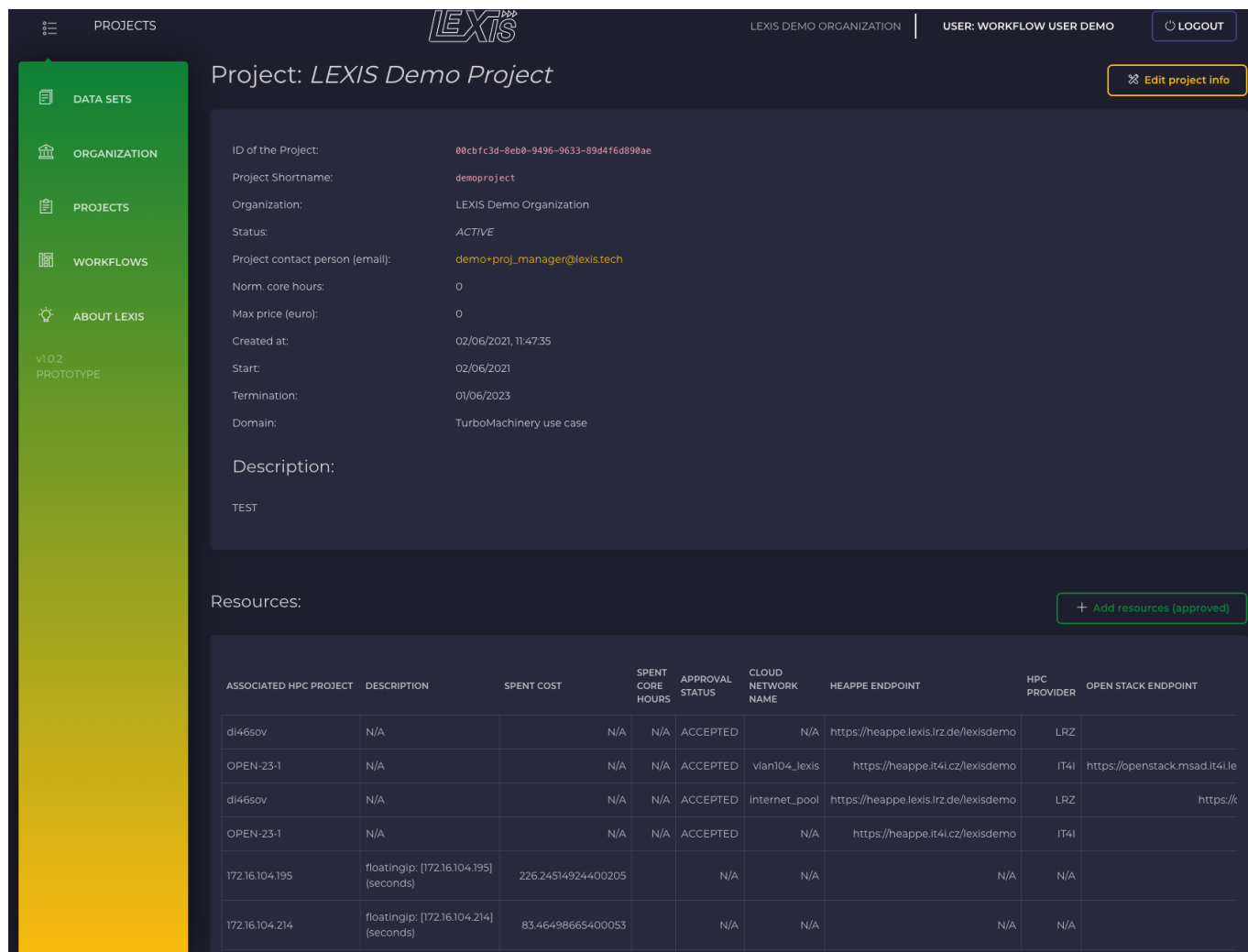


Figure 6 Project’s available resources, and spent cost view summary

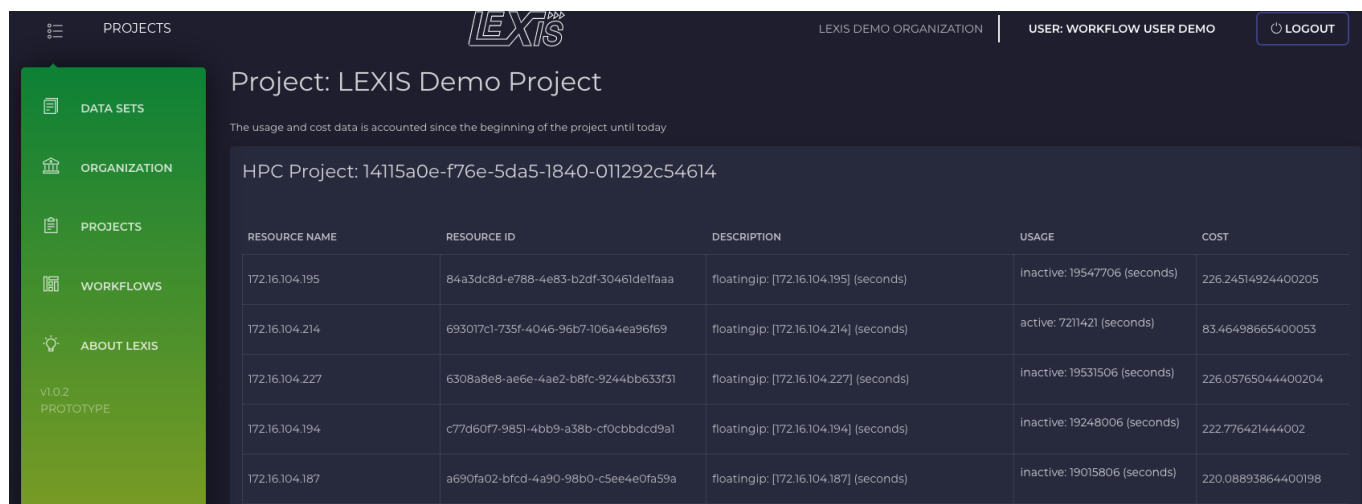


Figure 7 Detailed cost breakdown in the Portal

The LEXIS Portal allows users with the appropriate access to check on their organization’s and project’s resource consumption as well as spent cost (see Figure 6 and Figure 7). The Portal tracks both traditional HPC as well as OpenStack Cloud resource utilization and linked costs.

All of these above capabilities are strictly access controlled, and in most cases, the access rights of a user belonging to an organization can be managed by the organization manager. For more details on LEXIS Portal and related architecture and implementation notes, please refer to Deliverables D8.1 [7], D8.2 [8] and D8.3 [9].

### 3 FEEDBACK FROM LEXIS PILOTS AND LEXIS OPEN CALL APPLICANTS

To assess the Portal usability and identify which aspects were more used, we created a simple questionnaire which we circulated among the LEXIS Pilots and LEXIS Open Call applicants. The results are summarized here. As shown in Figure 8 below, the LEXIS Portal was perceived generally usable with subtle sign that it can be improved significantly. The x-axis range is from 1 (unusable) to 5 (excellent) for Figure 8.

How do you rate overall usability of the Portal?

9 responses

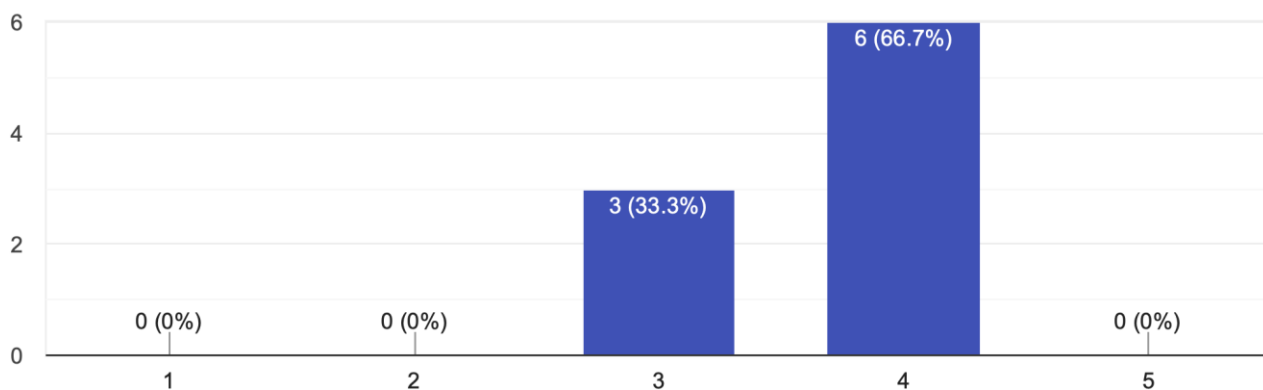


Figure 8 Portal Quick survey response on usability

Are you satisfied with the Portal theme and color choices?

9 responses

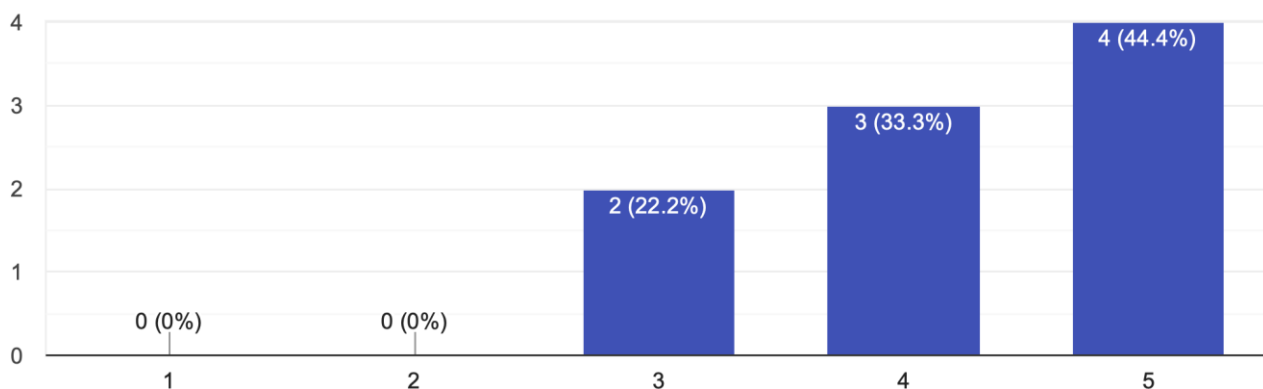
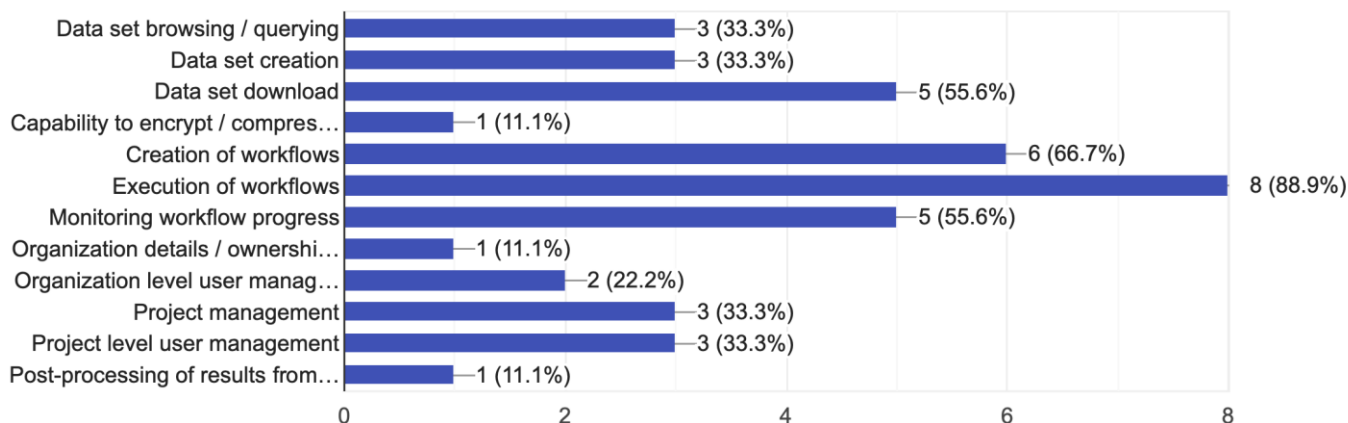


Figure 9 Survey response on choice of Portal theme selection

Figure 9 above clearly demonstrates general satisfaction among users with the transition to the new theme and colour scheme, 1 being unsatisfied and 5 being extremely satisfied. Creation and execution of workflows were the most popular activities which users performed via the Portal. The next popular activities were workflow monitoring and data set download. The trend is highlighted in the survey results as shown in the Figure 10.

**What feature(s) of the Portal you most frequently use?**

9 responses



**Figure 10 Frequency of usage of various Portal features**

**What role are you most often using in the Portal?**

9 responses



**Figure 11 Frequency distribution of users by roles**

Figure 11 shows the distribution of users by roles, and as expected, project member with workflow execution rights and organization manager was the majority of user groups among the survey respondents. Figure 12 below shows that the data set creation and workflow execution monitoring were the most intuitive functions in the Portal by a clear margin. Whereas as per Figure 13, it is clear that data set browsing experience as well as creation and workflow execution were not as intuitive as we hoped and there is clear room for improvement.

Which Portal functionality was most intuitive to use? (Select up to 3 choices maximum)

9 responses

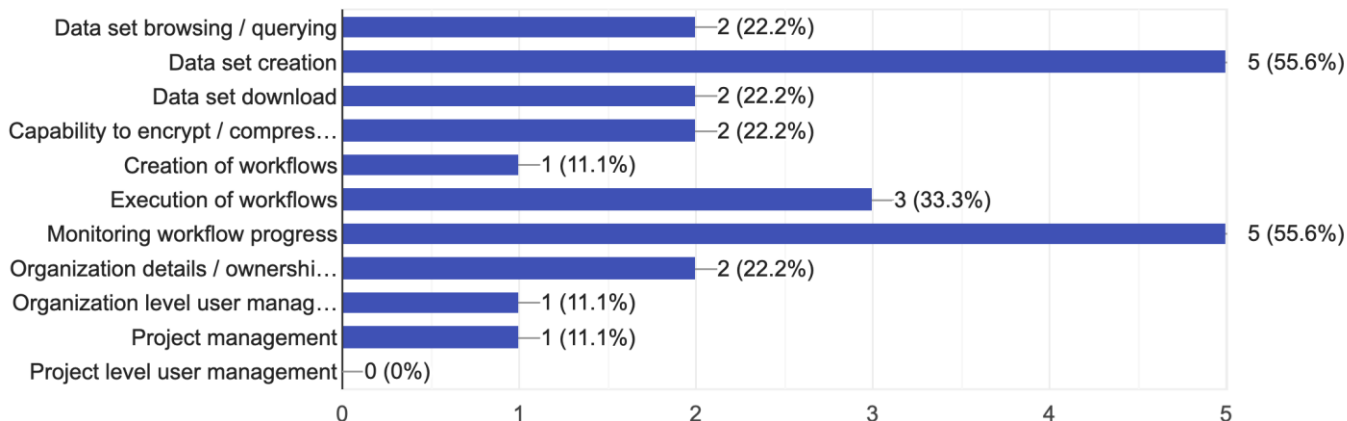


Figure 12 The most intuitive features selection by respondents

Which Portal functionality was most difficult to use? (Maximum 3 selections allowed)

9 responses

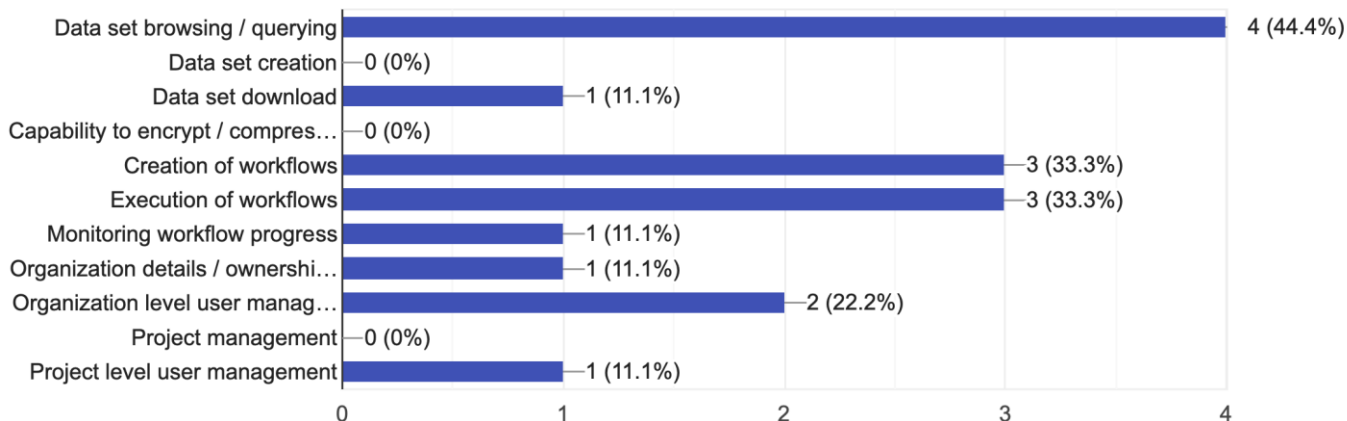


Figure 13 The most difficult features perceived by survey participants

The survey results also contained user feedback made of free text entries which gathered perceived missing capabilities which are summarized in the next Section 4.

## 4 SUMMARY OF MISSING CAPABILITIES AND REQUESTED FEATURES

The LEXIS Platform and Portal brought a system which allows users to leverage federated HPC/Cloud resources without the need of direct access to the cluster using a terminal. At this moment, the core Portal features such as dataset management, workflow execution and monitoring, user management with focus on security, are implemented and working. However, our long-term vision foresees implementation of new features which will make LEXIS even more user friendly and a tool sought out by SME, large industrial partners as well as research organizations.

At present, there are several features identified, that should be implemented in the future version of the LEXIS Portal. We can divide these into several groups depending on who identified the missing feature and according to the feature category. All the currently identified issues are shown in the Figure 14. Most of the features that are planned to be added in the future are user oriented.

		FEATURE SOURCE		
		SELF IDENTIFIED	LEXIS PILOTS	LEXIS OPEN CALL
CATEGORIES	GENERAL	<ul style="list-style-type: none"> <li>Organization registration and self onboarding</li> <li>Backend LEXIS core service status panel</li> <li>UI support for user belonging to several organizations with different roles</li> </ul>	<ul style="list-style-type: none"> <li>Make every action a 2-click process</li> <li>Bug reporting capability</li> <li>Explicit busy / wait / in-progress indication</li> </ul>	<ul style="list-style-type: none"> <li>Help guide about each section</li> <li>Portal notification system</li> </ul>
	DATA MANAGEMENT		<ul style="list-style-type: none"> <li>Improved data set download for large amount of data</li> <li>Possibility to explore compressed datasets</li> <li>Explicit flags identifying input and output datasets</li> </ul>	
	WORKFLOW MANAGEMENT	<ul style="list-style-type: none"> <li>Embedded workflow computational tasks progress visualization</li> </ul>	<ul style="list-style-type: none"> <li>Detailed description about each workflow template</li> <li>Auto refresh of workflow execution progress</li> </ul>	<ul style="list-style-type: none"> <li>Automatic refresh of workflow log messages</li> <li>Dataset selection in workflow template instantiation should be made more intuitive</li> </ul>
	SECURITY AND COMPLIANCE	<ul style="list-style-type: none"> <li>Audit logs preview</li> <li>Support for 2-Factor authentication</li> </ul>		
	ACCOUNTING AND BILLING	<ul style="list-style-type: none"> <li>Split accounting among multiple organizations</li> </ul>	<ul style="list-style-type: none"> <li>Information about used core hours per workflow execution</li> </ul>	

**Figure 14: Features planned to be added in the LEXIS Portal in the future**

The first feature we are currently missing is a self on-boarding feature. This means at the moment if we have a new organization that would like to use LEXIS services, they need to contact us and we need to create the organization manually in the Keycloak and userOrg backends.

Similarly, the current UI does not support user belonging to multiple organisations with multiple roles.

Additionally, we would like to create a status panel which would inform users about the LEXIS core services status, so they know which services are operational. As far as application workflows are concerned, we would like to support the autonomous creation of custom workflows by the users in the Portal. This should significantly lower the users’ reliance on the LEXIS administrators and the time needed to start working.

From the security and compliance point of view, we envision to provide two additional features:

One is 2-factor authentication, improving the user security, and the other is preview of the audit logs. Currently, the accounting and billing system does not support splitting of the bills between the organisations and aggregates expenses into one bill. Splitting of the bills among the service providers is planned in the next iterations of updates, so the clients will have clearer understanding of their costs and easier accounting.

From the pilots we received a feedback related to the dataset features, where they would like to have the possibility to explore compressed datasets. Right now, it is possible to list through the uncompressed datasets, view raster pictures, and edit small text documents directly in the Portal. Another request from the LEXIS Pilots was to improve the possibilities for the download of large datasets. Pilot users also identified lack of capability to report bugs from within the UI itself. They also recommended making most of the actions a 2-click operation compared to several steps it is required presently. The dataset listing currently does not identify a dataset as a part of workflow input category or output category.

The LEXIS Open Call applicants felt the current help options were not adequate and the Portal notification engine was limited in its capability. Automatic refresh of workflow execution status as well as log output messages were also identified as gaps in the current implementation.

## 5 FACILITATING FURTHER DEVELOPMENT

LEXIS consortium in general, and WP8 partners specifically have taken significant steps to ensure ease of continued development of the full LEXIS stack, and LEXIS Portal in particular. In order to ease development uptake by community development teams, the following are the minimum requirements:

- Adequate documentation,
- Appropriate licensing terms and conditions,
- Easily accessible code base,
- Readily available and cost-effective developers tooling.

### 5.1 DOCUMENTATION

LEXIS Portal development team have methodically documented the functional and non-functional elements of the LEXIS Portal at the public documentation site: <https://docs.lexis.tech/>. Figure 16 shows the landing page of the Portal documenting not only user journey within the Portal pages, but also further development hints in the form of developers' guide.

The LEXIS Portal code base has adequate documentation at code level itself. A few sample code snippets are shown below in Figure 15. Every function is adequately documented in crisp, human understandable manner.

```
249 // Handler returns an http.Handler given the handler configuration
250 // It mounts all the business logic implementers in the right routing.
251 func Handler(c Config) (http.Handler, error) {
252     h, _, err := HandlerAPI(c)
253     return h, err
254 }
255
256 // HandlerAPI returns an http.Handler given the handler configuration
257 // and the corresponding *WP3BackedDataServiceAPI instance.
258 // It mounts all the business logic implementers in the right routing.
259 func HandlerAPI(c Config) (http.Handler, *operations.WP3BackedDataServiceAPI, error) {
```

```

19 // newListProjectHPCApprovedResourceRequestParams creates a new ListProjectHPCApprovedResourceRequestParams object
20 // with the default values initialized.
21 func newListProjectHPCApprovedResourceRequestParams() *ListProjectHPCApprovedResourceRequestParams {
22     var ()
23     return &ListProjectHPCApprovedResourceRequestParams{
24
25         timeout: cr.DefaultTimeout,
26     }
27 }
    
```

Figure 15 Couple of code level documentation in Portal code base

## 5.2 APPROPRIATE LICENSING

A developer friendly licensing is quite important to enable continual development of a code base by open source community. The licenses linked with LEXIS modules are tracked and available in public Deliverable D9.10 [10]. In general, majority of LEXIS Portal components are released with Apache Software License v 2.0 which is one of the most popular licensing regime within open source community.



## LEXIS Portal UI

This pages provides informations about the user portal from the LEXIS project.

### Navigation

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[LEXIS Portal UI](#)

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- [User Guide](#)
- [Developer guide](#)

[LEXIS Data System](#)

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Figure 16 LEXIS Portal UI public documentation

## 5.3 EASY CODE ACCESSIBILITY

The entire LEXIS Portal code base has been released to the community in an unfettered manner over GitHub. The list of the code repositories is provided here for convenience, but more details are available in Deliverable D9.10 [10].

MODULE	GITHUB REPOSITORY LINK
Dataset-management-interface	<a href="https://github.com/lexis-project/lexis-backend-services-interface-datasets">https://github.com/lexis-project/lexis-backend-services-interface-datasets</a>
Portal front-end	<a href="https://github.com/lexis-project/lexis-frontend-general">https://github.com/lexis-project/lexis-frontend-general</a>
Portal back-end	<a href="https://github.com/lexis-project/lexis-frontend-portal-backend-services">https://github.com/lexis-project/lexis-frontend-portal-backend-services</a>
User-org-service	<a href="https://github.com/lexis-project/lexis-backend-services-userorg-service">https://github.com/lexis-project/lexis-backend-services-userorg-service</a>
Portal API	<a href="https://github.com/lexis-project/lexis-backend-services-api">https://github.com/lexis-project/lexis-backend-services-api</a>
HEAppE collector	<a href="https://github.com/lexis-project/hpc-usage-collectors">https://github.com/lexis-project/hpc-usage-collectors</a>
Gateway approval system	<a href="https://github.com/lexis-project/lexis-backend-services-interface-approval-system">https://github.com/lexis-project/lexis-backend-services-interface-approval-system</a>
Approval system interface	Same as above row (capabilities merged)

**Table 1: List of Portal modules and their GitHub code repositories**

Table 1 shows the LEXIS Portal modules and target Github repositories for ease of access by community developers.

## 5.4 DEVELOPER TOOLING AND SPECIFIC NOTES FOR QUICK ON-BOARDING

The LEXIS Portal is a result of contributions from several remote teams, therefore the selection of developers aid and tooling should be quite conducive for continued maintenance and enhancements by open source community or any other project teams in Europe and elsewhere.

Here is a quick summary of major technology stacks used:

- **Golang** - for all backend / non-user-facing Portal modules,
- **React** - for all Portal user facing views,
- **Go Mod** - for dependency and version management,
- **Swagger** - for OpenAPI v2.0 specification,
- **Docker** - software packaging framework,
- **Bash** - build and packaging scripts.

The technological stack used in the development of the Portal is a mixture of **Go** for the back-end and **React** for the front-end, with some **bash** scripting used on the initial and local stages of images building.

The interface services, the *user-org* service as well as the *portal-API* service share in common the use of several libraries and frameworks widely used within the golang (Go language) ecosystem (for the whole infrastructure, see Deliverable D2.4 [11]).

**Swagger** (OpenAPI Specifications) is used for the implementation of their respective RESTful APIs of the services of the LEXIS Portal. To be precise, the project uses the go implementation of swagger and specifically uses a template developed by the people from *Stratoscale* which, at the time when the development started, offered a most complete and comprehensive way of implement the functionality than the vanilla version offered by go-swagger 2.0. In any case, both of them follow the standards of the **OpenAPI v2.0** Specification.

On the security side, the services rely upon two major contributors: Nerzal's **gocloak** library and the **Keycloak** library developed in-house by the WP4 (see Deliverables D4.5 [12] and D4.7 [13]). The last one provides the services with an abstraction layer for the complexity inherent to the permissions and groups that conform to the RBAC/ABAC matrix that LEXIS uses [14], and the former let us have an abstract and light interaction with **Keycloak** tokens.



For the internals of the services we end up depending on several featured libraries such as **gorm** for the database interactions, spf13's **viper** for the interaction with the configuration files, **Cyclops'** logging library to have a consistent and simplistic logging approach for all the services, RS' **cors** for the CORS needs of the *portal-API* service, and **Gorilla's** sessions and **securecookie** for the sessions and cookies management of the LEXIS Portal BE service, as well as other small replacements that provide a significant improvement over the standards such as Segmentio's encoding libraries.

The software was prepared to be easy to understand for further developers as much as possible. The guides are accessible online in Lexis Developer's Guide and in source code repositories. In general, the source code repositories contain also scripts for preparing development environment for developers. The software development standards are also mentioned in document of *Quality Management Process* and *Internal Guidelines for Software Development* created for internal project purposes.

LEXIS Portal code that is directly accessible from user interactions is statically analysed, tested for build errors and tested on different user scenarios by simulating user behaviour. All of these operations are handled by CI/CD when developer commit new change to the repository.

The CI/CD platform used in the LEXIS Project is GitLab, which has a proven build and artefact workflow configurations. As LEXIS Portal code repositories contain the Docker container build scripts, if someone chooses another CI/CD pipeline, it should be straightforward to recreate the stages used within LEXIS development teams.

The development environment depends on service type. For example, for the GUI development there is a "mockup" back end, which can substitute the other services behind the Portal API. More info about the development environment can be found in the Portal repository in README file.

## 6 SUMMARY

This deliverable sets the stage for potential further development of the LEXIS Portal by community or within future European consortium. The survey results by LEXIS Pilot and LEXIS Open Call applicants have been analysed and their responses, together with our internal assessment have helped in identifying features which would add more usefulness to the Portal. In order to improve the new developers' onboarding with the current codebase, list of key resources: documentation, links to code repositories and summary of key libraries used are presented.

## REFERENCES

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