

# Deliverable report

**COMPLEAP**

Date: 31.10.2019

Work package: WP2 Requirements and architecture design

Title: D23 Sustainability Plan

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## Description of the action:

*This sustainability report looks into the various steps taken to achieve longevity of project results. It details how the project has ensured that the results remain usable even after the project ends.*

*This report details first how we have ensured during the project implementation that what we are doing is relevant, useful, applicable and utilized after the project. We detail how and why we have included stakeholders in various parts of the project.*

*Subsequently we describe how the results of the project could be utilized in the future with detailed technical input from the developers involved in the project so far.*

*Sustainability factors have been part of the development work throughout the project.*

## Outcome of the action:

The first part of the report goes through key sustainability factors:

1. Project design and implementation
2. Human resources
3. Ongoing evaluation
4. Internal communications
5. External legitimation
6. Stakeholder engagement

Thereafter the sustainability and future prospects of specific project outcomes are discussed. This segment will also describe what would need to happen for the prototypes to be taken into production use in EU-countries, Finland as an example.

Sustainability of the results of the CompLeap project has been addressed e.g. by active and continuous stakeholder involvement, investing in interoperability and open standards supported by the project, as well as conducting regular reviews of how the project is evolving.

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## Introduction

The ComLeap project has aimed to build a learner-centred ecosystem of digital services and products around skills and competences. A key driver has been to better match competence supply and labour market needs, serving individual citizens, employers, decision-makers and, ultimately, the society at large. More specifically, the project has offered a possibility to discuss with learners and guidance professionals how they would optimally want to achieve a learner pathway based on enhanced self-awareness and responsive education offer.

ComLeap has provided the opportunity to develop a learner-centred approach to competence development and provided concrete steps towards achieving such a goal. How this work will continue and the work will be utilised in the future is detailed below. As such this report details how the sustainability of the project results have been planned, and how the project results will live on.

The first part of the report goes through key sustainability factors:

1. Project design and implementation
2. Human resources
3. Ongoing evaluation
4. Internal communications
5. External legitimation
6. Stakeholder engagement

Thereafter the sustainability and future prospects of specific project outcomes are discussed. This segment will also describe what would need to happen for the prototypes to be taken into production use in EU member states Finland as an example.

## Impact evaluation

Also, a separate impact evaluation will be conducted by the Finnish Education Evaluation Center FINEEC. The evaluation aims to be forward looking and will capture lessons learned and provide information on the nature, extent and where possible, the potential impact and sustainability of the ComLeap project.

## Sustainability factors

Sustainability factors have been part of the development work throughout the project. Below we will go through how each of the key sustainability factors has been taken into consideration, and what the outlook is for the future.

### Project design and implementation

The project design has left much room for manouvering during the project. This has meant that learning occuring during the project has been integrated into project implementation. The methods to reach the aims of the project have been flexibly modified during the project timeline. Additionally, we have aimed to plan, delegate and disseminate project aims and outputs in a clear and structured manner.

During project implementation, stakeholders have been involved to collect and disseminate knowledge, and successes related to the development of the project's results have been disseminated to project partners, associates and reference group members via regular webinars and other dissemination methods.

### Human resources

Many of the CompLeap team members are permanent staff of the organisations and as such the learning and experiences gained will live on in the organisations. The several changes in the project team during project implementation have both brought in additional valuable expertise and placed strain on the ability for the team to keep moving. Induction within and between each partner organisation has been a challenge due to the sheer complexity of the project and the short timespan available for the finalisation of the project work.

The project team has been comprised of versatile professionals in the field, all providing their unique mix of both project management and digital service development skill. Team members have been provided with training (for example Scrum Product Owner) to maintain an agile way of working. Different competences and backgrounds have complemented each other in order to complete the very versatile tasks in flexible way. The resourcing has developed and the human resources have constantly grown throughout the timeline of the project.

### Ongoing evaluation

During the project, each deliverable has been confirmed by the steering committee, who have given advice on how to continue with the project. As an internal progress evaluator, a project management committee (consisting of project managers from each consortium partner) has reviewed the progress of each project outcome during different stages of the project. The project roadmap has guided the weekly and monthly work of the project team, and provided the concrete space for ongoing monitoring and evaluation.

Stakeholder interaction and evaluation has also been integrated in all stakeholder events, with the ongoing provision of feedback on both project work and prototype development.

### Internal communications

We have ensured a steady information flow about project developments with the help of weekly online meetings, Slack, and emails. Additionally, a steady flow of information from the project has been ensured also with interested partners and leaders within partner organisations.

The results and developments have been shared in organisation wide webinars, as well as in weekly unit meetings at a regular pace.

### External legitimisation

Wide stakeholder interest towards CompLeap project show the relevance of these issues in European societies at the moment. For example, in Finland, as an example country, the themes of lifelong or continuous learning, lifelong guidance and competence development have been a very hot topic during recent years. The next bigger reform in the field of education will be the reform of continuous

learning and therefore Compleap has been very current and up-to-date project in this context. The new government program of Finland also highlights needs to create user-friendly, interoperable digital services and ecosystems so the learner-centered digital ecosystem architecture created in the project can be basis for the future development.

On the EU level situation is comparable since skills and competences issues are constantly current topics like the digital solutions supporting lifelong learning. On the EU level, one challenge for sustainability is of course the fact that EU member states are each in quite different phase with their digital infrastructures and it's up to each country what kind of decision they are planning to make. Anyway shared framework architectures could benefit EU-wide collaboration and even help in creating steps toward harmonizing digital infrastructure in EU.

### Stakeholder engagement

The main idea in the starting phase of the project was to identify all relevant stakeholders and to contact them. Thereafter, we have invited them to our stakeholder kick-off seminar which was organised in Helsinki on April 9<sup>th</sup> 2018. There, we presented our key stakeholders the idea of learner-centered digital ecosystem of competence development and the idea of framework architecture design. The seminar was also the kick-off for the joint collection and validation of prototype development. Thereafter we have in unison decided which prototypes would be developed in the project.

Stakeholders of the project have been mapped into four groups:

1. End users -> They are going to test and pilot the Compleap prototypes.
2. Facilitating users -> They will use Compleap prototypes as a tool for guidance or support end users to use Compleap.
3. Decision makers -> They will decide whether CompLeap will be used as a facilitating tool for end users.
4. Interested parties -> They are interested or involved in supporting lifelong learning.

Learners and guidance counsellors have been at the centre of service planning and needs analysis from the very beginning. Learners are included in the testing and piloting of the prototypes.

The Compleap reference group has comprised a heterogeneous group of "facilitating users" as listed above. We have been creating and maintaining interest towards the project and its results through active dissemination. Open webinars on monthly basis have been held to Compleap reference group members. These webinars have discussed thematic issues around the creation of Learner-centered digital ecosystem of competence development and interlinked these constantly to the concrete prototype development. These webinars were helpful also in mapping needs of education providers and guidance counselors before creating prototypes.

In addition to the more thematic stakeholder webinars, we have organised open demo sessions to all stakeholders, to constantly validate and follow the process on prototype development. This has created an engaged community around the project that will also maintain the project results after the project ends.

In parallel with webinar and demo sessions organised online, we have participated in educational fairs in Finland and internationally with a project stand. There we have offered end users and stakeholders an opportunity to test and give feedback about our prototype.

A key element in creating long lasting relationships has been the piloting and evaluation of prototype with end users and guidance counsellors. As such, the most engaged stakeholders have been our piloting partners (OSAO, REDU, JEC).

For the framework architecture key has been the continuous evaluation of the ComLeap framework with national and international institutions (e.g. Ministries, agencies, Europass). The most active members have been the Finnish Ministry for Education and Culture (also member in project Steering Group) as well as the international organizations that have taken part in the piloting of the architecture as described in Deliverables 27 and 30.

## Sustainability of Specific Project Results

### Framework Architecture

So far, what has been done in international piloting is covered in D27 whereas a summary of the results of international piloting is covered in D30.

In the future, learner-centered framework architecture design created in the project could be used either in member state level or EU level. Project has shown that such shared architecture design is needed if member states or EU is willing to create user-friendly and interoperable services or service ecosystems. Still, it seems like also in member state level nor EU level such design methods are not that well in use yet although they are based on the international standards (TOGAF). Enterprise architecture is also seen many times only technological tool although it is supposed to be covering all levels from strategy to technological level. After all, ComLeap has shown that either in member state level or EU level such design could significantly support the digitalization and digital business transformation.

In Finland the framework architecture design has already been presented to many stakeholders and the received feedback shows that there is major potential in using such method and tools in co-operation across different administrative branches the cross-sectoral collaboration. Basically there is two different options that can be seen as a way to sustain the work done in the project: either ComLeap architecture design is integrated to existing reference architectures or there will be totally new cross-administrative branches and cross-sectoral architecture design created that can use ComLeap work as its basis and starting point from which the development can go on. Anyway, no decision has been yet done but it's expected that in either case ComLeap work will support the development of such digital ecosystems like case Finland is proving.

The architecture design was created on a high and generic level so that it could be suitable also in other EU countries. During the project it was presented in the workshops in the Netherlands, Germany, Estonia and Croatia and further presented in different kind of EU level events. (Europass working groups, Learning by Leaving etc.). Methodology on its technical level was familiar also in other countries but the challenge is that enterprise architecture as a holistic tool (strategy, business etc. levels included) was not that well known and to really be able to use such architecture design as a tool there should be more promotion work done. Case Finland shows how in quite short time actively involving the stakeholders to this shared architecture design different partners started to realize its benefits for collaboration and strategic development. One could say that without such design it might be quite challenging to create user-friendly ecosystems for lifelong learners neither in any member state nor EU level as a whole.

On EU level the sustainability of such frameworks is much more of a challenge. EU does not actually have mandate that would make the use of such architecture design mandatory to all member states so it's really up to each member state to choose how they are building their ecosystems for learners. Anyway, the workshop with Europass showed that with the use of such architecture design EU level services could be much more closely integrated to national digital infrastructures so it might be useful to use such methodology also in the EU level instead of many several platform projects that many times are not too well connected together.

#### Interoperability with other systems

Enterprise architecture is a tool of visualizing the current state of digital services and at the same time first step in the creation of interoperability between different services and data sources. Like Compleap architecture design shows it can help seeing the "big picture" of national service ecosystem or even wider scope like EU-level. In this project we did not yet create any integrations between the services from different administrative branches but relevant services were quite well identified and visualized. With such framework architecture the technical creation of interoperability would be much easier when the context is better understood because of existing architecture as a starting point of development.

Architecture design is always a process instead of project so to guarantee the sustainability should the architecture design constantly be updated based on the identified changes in the environment where the development takes place.

#### Prototypes

After the end of the project, the prototypes will be utilised to visualise the potential of bringing together different data in a learner centered way. This will be central in the further planning of the competence mapping services being developed for learners in the future.

The main service framework in which the Compleap results can be utilised in Finland is Studyinfo. At the moment the whole Studyinfo portal is undergoing a major renewal. In this context there will be interesting prospects for the integration of the project results in the renewed service. The Studyinfo portal houses the study offer of all educational levels in Finland. In the second section of this report we have researched the opportunities for taking the prototype into production use in the full Studyinfo setting.

The prototypes developed are free for use and for uptake in any national setting. The prototype will be up and running in the Studyinfo test environment at least until the end of June 2020. After this, the code and technical documentation will be available in the EDUFI Github repository. Additional information on the development of the prototype as well as the technical specifications will be available also on the Compleap eDuuni webpage at least until November 2020.

#### Technical information

All Compleap prototypes have been developed with open source code and have been openly available for further development and use. The source code for Compleap Prototype components is contained in the EDUFI Github repository.

- The service prototype (PoC) is available at <https://poc.compleap.testiopintopolku.fi/>

- All the open source code for the PoC is available here: <https://github.com/Opetushallitus/compleap>
- Technologies: JavaScript, React, R, AWS (infra)
- Release notes: <https://jira.oph.ware.fi/jira/projects/CL?selectedItem=com.atlassian.jira.jira-projects-plugin:release-page>
- Bugs: <https://jira.oph.ware.fi/jira/secure/RapidBoard.jspa?rapidView=163>
- Licence: EUPL 1.2 and subsequent versions. The full licence text has been added to the EDUFI Github repository.

The HTML-prototype is available at <http://compleap-proto.testiopintopolku.fi>. The source code and documentation for the HTML-prototype is available at: <https://github.com/Opetushallitus/compleap-proto>

### Communications and Project Materials

To be able to provide information on the project results even after the project ends, the project management committee has decided to maintain the webpage and eDuuni intranet pages for a year after the end of the project up until November 2020. The eDuuni content will be tailored to display the key documents and results of the project to provide further information to those interested in further developing the prototype.

The user profiles, user requirement and architecture images will remain available for further use on the eDuuni pages. This way the further development of CompLeap services or services like it can be facilitated.

## Research on Possible Integration to Real-life Environments

The below segment details in detail what would be required in order for CompLeap services to be taken into production use. It describes in detail **how final outcomes of the project could be integrated in real-life environments**. We present the differences from real-life APIs to the mock-up data used, and how the CompLeap results can be integrated into existing services or frameworks, hence creating added value for service providers and for users.

For simplicity, we consider here a case where we would productionalize the ideas presented in the PoC in Finland as a part of Studyinfo<sup>1</sup> –portal. The reason behind this is that many of the data sources are country specific and without extensive study, it is hard to say what kind of data is available in other countries. Data availability and quality has a great impact on what kind of tools and techniques can be used in suggestion algorithms.

First, we discuss how to extend the PoC to cover all levels of education and how to weight the education opportunities according to predicted future need of competences. The goal would be that students in all phases of their education path can use this service to find education opportunities that are the best suited for one's own competences, interests, goals and need in the society.

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<sup>1</sup> <https://studyinfo.fi>



Competences in this context are proven, i.e. completed formal education. The main source for this information is KOSKI service (the national repository for study records), which is already part of the My Studyinfo -service.

Next, we show an overall architecture plan how integrate the PoC prototype into production environment within My Studyinfo. Further, we discuss lacking features and needed improvements of the PoC that would be needed in the real life use.

### Utilizing and Extending the CompLeap prototype(s)

In this chapter we go through the additions (Figure 1) which would be needed for the current PoC prototype to make it a useful addition to the Studyinfo. The aim is not in extensive specification or requirements documentation of the software but an initial feasibility study with listing of data sources, possible technical solutions and challenges.

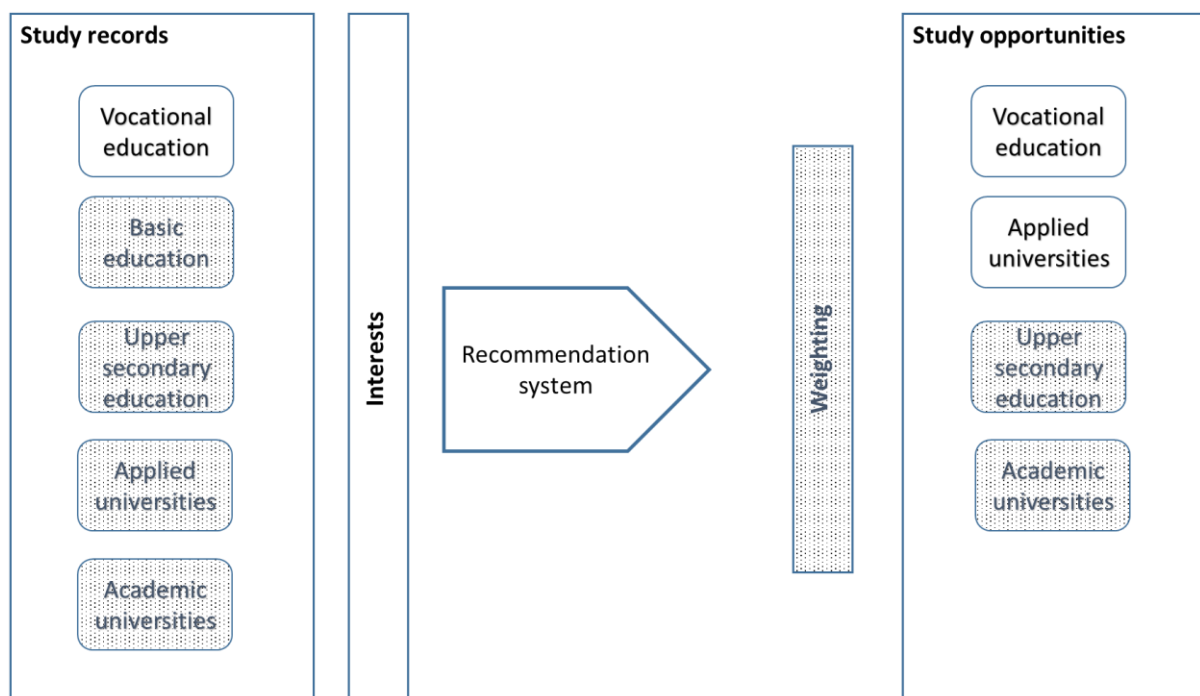


Figure 1. Overview of data sources and functionalities of the current PoC (in white) and wanted additions (in gray). In a summary, there is a need for adding basic education, upper secondary education and university study records as a data source. On the right side of the picture we want to add weighting of recommendation results and possibility to recommend upper secondary schools and academic universities.

### Inclusion of all proven study records

Present PoC uses vocational education and qualification records as a source for verified sources for competences. **However, if taken into production use, it would be necessary to get records from all levels. This would mean inclusion of study records from basic education, upper secondary schools and universities.** Below we will detail option for how this would be feasible to achieve.

To get the study records of basic education, upper secondary schools and universities from KOSKI and including them into the service, is straightforward. However, both the recommendation and ESCO matching algorithms need the descriptions of the studies as well. KOSKI itself does not include

them, they are retrieved from eRequirements service. Service includes basic and secondary education but **not universities**. Inclusion of study records from all levels, would need some user interface and visual design, not only data gathering.

#### Basic education and upper secondary schools

To include basic and upper secondary education into PoC prototype, we would need to list study subjects (for example mathematics, biology, mother tongue and literature, foreign languages), which would then be thumbed up or down, depending on student's personal interests on the subject. Records are readily available from KOSKI. The shown subjects would be the unique set of user's study subjects found in KOSKI by level (i.e. basic or upper secondary).

The descriptions of the basic education and upper secondary studies are available from eRequirements service similarly to vocational education. They are municipality and school specific, so the organisation information from KOSKI is needed too. It requires some work to go through the eRequirements data, filter and pre-process it to get suitable textual descriptions of content for recommendation and ESCO matching algorithms. On the other hand, the possible set of study subjects is so limited, that it does not pose any problem to write descriptions of those and not use eRequirements data at all.

#### Universities

In case of universities (both applied and academic), it is more complex to get the all data needed to extend the PoC to include them in the current competences of user. University study records of a single user can be pulled from KOSKI but their descriptions are harder to come by. The eRequirements –service, source for descriptions of proven competences in PoC, contains only basic, upper secondary and vocational education.

There are couple of options for getting textual descriptions and thus word / document vectors for completed university level studies. **The first**, and simpler, approach would be to use course names in completed study units to form document vectors. Unfortunately, the information content in those name labels is quite limited and varying. **The second** option is to source the descriptions from universities, which would be a considerable effort, considering that we would not only need the descriptions of current curriculum but those of the past too.

Further, to follow the logic of current PoC, the completed studies composed of individual courses need to be grouped somehow. In vocational education and qualification all of the degrees compose of study units, which was then a logical choice for aggregation. However, in universities the hierarchical system is different and at least partly their naming and descriptions are not so useful for the natural language processing algorithms used in the PoC.

#### Extending offering of study opportunities

At the moment, PoC can recommend study opportunities in vocational institutions and applied universities. To get extensive coverage for all possible study opportunities, academic universities and upper secondary schools should be added too. After these additions, the service would be able to recommend all open study positions from the secondary to tertiary organisations.

## Universities

The inclusion of universities would be quite straightforward as Studyinfo portal contains the relevant textual data in similar format that is now used. However, some problems exist as the data is not as good quality as is the case with government controlled vocational education, where the contents and quality of the textual descriptive data is quite uniform. This problem was already present with addition of applied universities in the PoC and was not yet fully solved. In the worst case, there would be a need for streamlining the textual content of study opportunities. Partly, this could be automatized with NLP techniques, where the aim would be removing institution specific information from grouped description view of offered study opportunities.

## Upper secondary schools

In addition to universities, the addition of upper secondary school to study offering, would be relevant. When compared with other secondary level education (vocational education and qualification), there is only little variance within upper secondary schools, so it is easier for student get knowledge about that alternative and probably the most are well aware of this possibility. However, the service should not be discriminative towards any study opportunity and this should be added to service.

Every upper secondary school has their own description data, so technically it could be possible to offer organisation (school) level recommendations for upper secondary level schools. However, in practice the descriptions are quite similar to each other and do not contain relevant information similar to completed study descriptions. So, there could be just one general "Secondary upper level" opportunity shown at the list of recommended study opportunities. Still, there is some variation in curriculums of different schools and quite many of them offer special weighted curriculums and lines in some specific study subject. Further there are some schools which have a dedicated general specialisation (sports, riding, language, handicrafts etc.). To include all specialisation lines and schools to current PoC service, would need quite substantial work in gathering all the data that the current algorithms need. It is up to debate, whether it is in scope of this service to broaden more towards selecting between upper secondary schools.

## Extentions Summary

- Getting study records from KOSKI is easy for all levels of education.
- Getting descriptions of studies needed for recommendation algorithm might be quite laborious for universities but easy for basic and upper secondary education.
- Adding academic universities to recommended study offering is straightforward.
- Adding upper secondary schools in recommendations poses some challenges but is achievable.

## Quality and performance of recommendations

From computational performance side, the current algorithms are scalable and in that way portable for production use as a part of Studyinfo. However, as already discussed in technical descriptions of recommendation and ESCO matching algorithms, there is room for improvement in their accuracy.

For production use, the algorithms need further development and testing. First steps could be moving from document embeddings to sentence embeddings, getting more data from interests, and trying out other algorithmic approaches in matching of competences and interests to offering.

In production, we would face other kind of challenges too. Probably, we wouldn't want to recommend study places that user is not eligible to apply. This would need logic based rules based on user's proven study records. Also, currently the PoC recommends only 10 different opportunities and we probably would like to add more for user to choose from. Finally, more filtering in addition to area would be needed.

### Integration into Studyinfo

Independent of the current or the future technical solution of the Studyinfo –portal, the recommendation system could be developed and integrated using microservices architecture, where components needed for recommendation are developed independently and accessed through REST APIs. Microservice architecture offers good maintainability and makes further development of algorithms easy and independent of Studyinfo. Figure 2 shows a very general overview of the architecture.

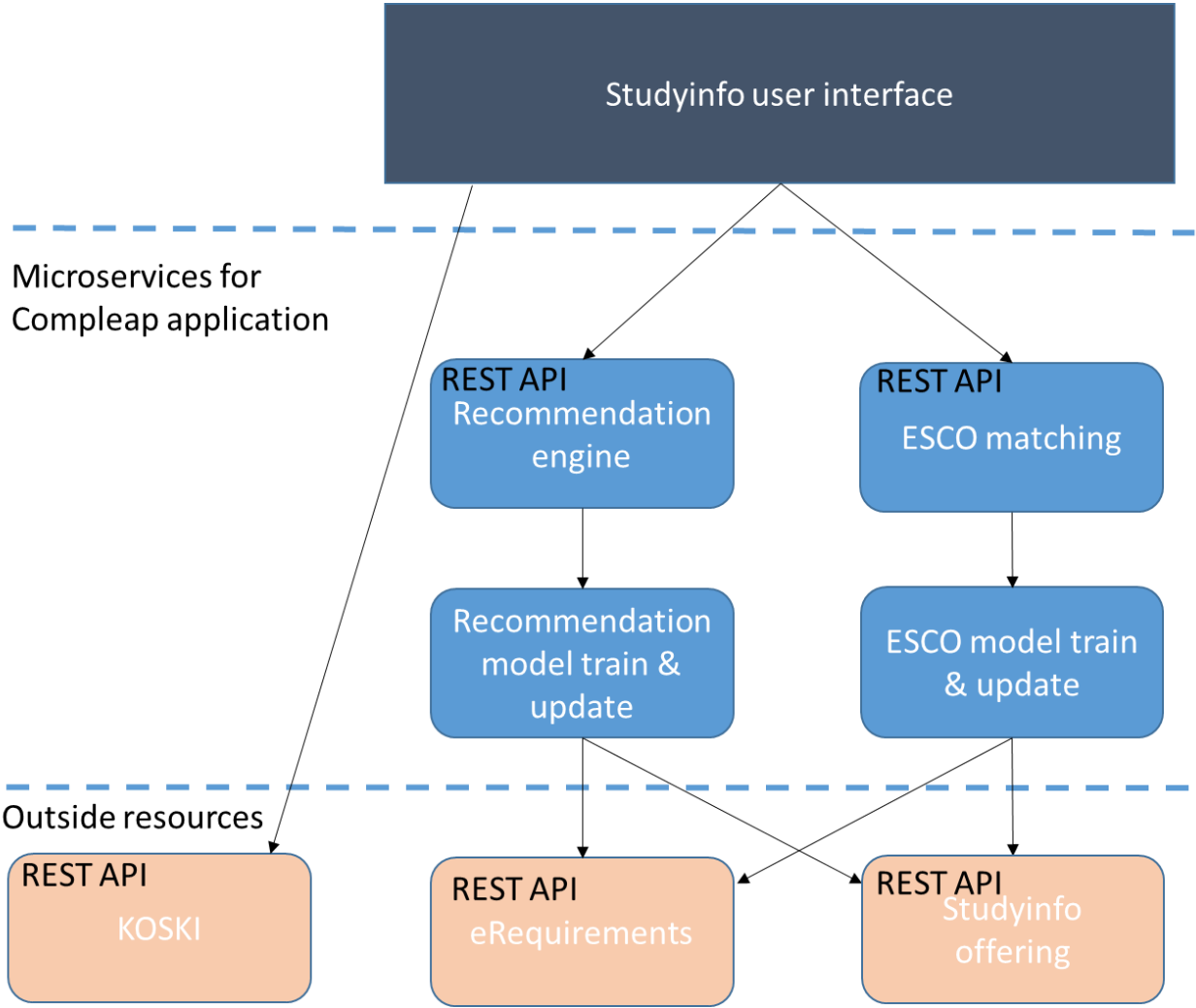


Figure 2. General architecture for integrating Compleap PoC prototype into current My Studyinfo service. The idea is to use microservice architecture where functionalities are in individual containers and accessed via REST APIs.

### Automated data flow and model updates

In the PoC we used data dumps from eRequirements and Studyinfo to get the data needed for recommendation algorithm and to the user interface of PoC prototype. In real life situation we would automate these as batch jobs and run them, for example, daily together with model updates to have the new data and models in the application. The models are stored in their own containers, which make their modification and update independent of the actual service. All components could be deployed as containerized microservices on a docker and accessed through APIs.

### User authentication

Current PoC does not use real secure authentication because it uses just mock-up data. If integrated to My Studyinfo –portal, the user authentication is already provided and required to use the service. With secure authentication, we can get the personal KOSKI data and pass it as an input to recommendation engine and ESCO matching microservices.

### Support for other languages

In the current version of PoC, the NLP algorithms at the moment support only Finnish language. To include all study opportunities from Studyinfo, there should be support for Swedish and English at least. The easiest solution would be to translate all non-Finnish material to Finnish and use it as the language of the algorithms. This approach was already experimented with ESCO tagging, where Swedish study unit descriptions were translated to Finnish. If all the user interface contents (from KOSKI, eRequirements and Studyinfo offering) are needed in other languages than Finnish, it would need quite substantial work.

### Integrations Summary

- Microservice architecture can be used to integrate PoC prototype into part of MyStudyinfo service
- Scheduled update of eRequirement and offering data together with model re-training
- Secure authentication is already provided in My Studyinfo
- Support for other languages and inclusion of non-Finnish data as an input to the algorithms

## Summary and Conclusions

During the ComLeap project the focus in supporting sustainable project results has been in creating the necessary institutional support for the results to be taken up and taken further.

Achieving sustainable project results has required linking the developed ecosystem and its interconnected modules to already existing infrastructure. This makes it possible to incorporate even only parts of it to the national infrastructure. Additionally sustainability of the results has been addressed by active and continuous stakeholder involvement, investing in interoperability and open standards supported by the project, as well as conducting regular reviews of how the project is evolving.

At the current time there are wide political reforms relating to lifelong learning in Finland, as well as a large scale reform happening within the main portal to which CompLeap could be linked within the Finnish service framework Studyinfo. The findings from this project can and will be utilised in both these reforms.

The research conducted on the real life integration of project results will be useful in the possible uptake of the project results in Finland, but also internationally.