Underground laboratories – Quality assessment and analysis (WP3.4)

Baltic Sea Underground Innovation Network (BSUIN)

Interreg Baltic Sea Region
EUROPEAN REGIONAL DEVELOPMENT FUND
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BSUIN

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REPORT

WP 3.4 Quality Assessment and Analysis

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Table of content

Content

Tables of Figures

1. BSUIN project introduction

The aim of the Baltic Sea Underground Innovation Network (hereinafter BSUIN) project is to make the underground laboratories (hereinafter ULs) in the Baltic Sea Region (BSR) more accessible for innovation, business development and science by improving available information about the ULs and their operation principles and opportunities therein. In addition, the BSUIN project aims to collect the safety protocols of each UL as well as experiences of their respective users to aid further development.

BSUIN is a collaboration project between 13 partners from eight (8) BSR countries. Besides project partners 17 associated partners contribute for achieving the project goals.

The BSUIN project is participated by six (6) ULs from the BSR area. Each of the ULs will be characterized and presented to potential customers in order to attract developing innovative activities and effectively activate use of those laboratories. These six underground laboratories by name are:

1. Callio Lab, Pyhäsalmi mine, Finland
2. Äspö Hard Rock Laboratory, Oskarshamn, Sweden
3. Reiche Zeche, TU Freiberg Research and Education mine, Germany
4. Lab development by KGHM Cuprum R&D centre, Poland
5. Khlopin Radium Institute Underground Laboratory, Russia
6. Ruskeala Mountain Park[1], Russia

The main outcome of the project is a sustainable network organization, which will disseminate technical, marketing, operational quality, training and other information about the BSR ULs.

Project is funded by Interreg Baltic Sea funding cooperation. Its duration is 36 months with a total budget of 3.4 M€.

[1] The name Ruskeala Mining Park is used in some texts. Herein we will adopt the term “Ruskeala Mountain Park”.

2. Content of present document

2.1 Document justification

This document is part of the Work Package (hereinafter WP) 3.4 output. The objective of WP 3.4 is to analyze the current state of UL-specific services (see CSA in WP 3.3 report) and to identify and study factors that support or hinder the innovation process in ULs. Based on the general approach of the innovation platform concept and the analysis of the current state of innovation management some more specific hints to improve the innovation processes at the BSUIN ULs are given at the end of this report.

The original plan was that the output of this project activity would be a decision tree-based online tool that could be used for evaluating whether or not a given R&D project could be conducted in a given UL. The idea was to generate a service that includes filters that can be used to screen between individual ULs so that the user would find a selection of appropriate ULs for its particular needs. This decision-tree based system would have contained information of the research fields each UL is specialized on. It would also have contained information on the types of logicistical and technical supports each UL has to offer. It was further planned that this service would be updated regurarly to contain up-to-date information. The level, quality an amount of available information differs strongly among the Uls. This hinders to creat a unified keyword link-system to build a proper decision tree-based online screening tool. Nevertheless, the information collected in WP 3.3 and WP 3.4 can be used to sketch examplary the mode of operation of decision tree-based system for site selection.

2.2 Content description

The innovation platform concept developed in WP 3.3 (“Underground laboratories Innovation management – A guidline for innovation management and support for innovation processes”) and the decision-tree based online screening tool planned to be developed in WP 3.4 were described to be essential parts of the BSUIN web-based tool. However, the questionnaire sent to the ULs may have been too limited in scope, or at least such a conclusion can be made based on that the number of answers do not allow constructing such a definitive online screening tool.

The questionnaire (see annex of this report) was sent to representatives of six ULs, namely to Callio Lab (Finland), Äspö Hard Rock Laboratory (Sweden), Reiche Zeche (Germany), KGHM Cuprum R&D centre (Poland), Khlopin Radium Institute Underground Laboratory (Russia), and Ruskeala Mountain Park (Russia). From these six ULs, answers were got from all except Cuprum, the latter which was unable to answer. Therefore, all results of the questionnaire of WP 3.4 represented in the following sections are based on the answeres from five separate ULs. For the sake of simplicity, the following short names are used when referring to them:

- Callio = Callio Lab (Finland)
- Äspö = Äspö Hard Rock Laboratory (Sweden)
- Freiberg = Reiche Zeche (Germany)
- Khlopin = Khlopin Radium Institute Underground Laboratory (Russia)
- Ruskeala = Ruskeala Mountain Park (Russia)

3. Results of the questionnaire for ULs

3.1 Capabilities of the ULs for innovation management (Question UL.1)

From the five ULs that answered the questionnaire four have a system for Innovation Management (IM), while in one it is in the planning process. Table 1 summarises the answeres of the respective ULs. The result reflects to some to degree the history and development process of the different ULs. The idea of an active IM is more accepted and might be easier to implement for ULs which are permanently used or even owned by universities such as Callio and Freiberg. The importance of an Innovation Management is recognized by all ULs. The actual realization of the IM process is influenced by the number of users, in particular the ones from "outside" and long-lasting partner organization which was mentioned by Klopin.

Table 1. A summary of which ULs have an established system for Innovation Management.

UL	**Existing system for innovation management**
Callio	Yes
Äspö	Yes
Freiberg	Yes
Khlopin	No (but in planning)
Ruskeala	Yes

3.2 Capabilities of the ULs for innovation support (Question UL.2)

An IM process is already implemented in few of the ULs, but not in all of them. It is hence important to understand how a given UL supports their customers' innovation activities. Therefore, the questionnaire included a question UL.2: "Does the UL support / will it support innovative processes of their users? If yes, how?". The available options for the ULs to choose from were:

- Technical support (yes/no)
- Legal support (yes/no)
- Funding support (yes/no)

- Networking support (yes/no)
- Guiding to other organisations (yes/no)
- Other: _____(which) _____

The answers for these questions are summarized in Table 2. According to the answers, four of five ULs offer technical support for their customers. The only exception is the Callio Lab in Finland that has not this service type available. According to the answers, legal, networking and guiding support are offered in all ULs but Khlopin, which does not give any of these support types. Support for funding is provided as a service by two ULs, namely Callio in Finland and Khlopin in Russia. It may be that funding support is heavily related to the backgrounds of the personnel working in a given UL: if the UL personnel have a strong background in scientific and technical research the customer is involved in, the UL may be willing to become research partners of the customer. In such cases the ULs may be highly motivated and skilled to give support for getting funding for the collaboration research. However, neither the questionnaire nor the anwers are clear about this.

Table 2. A summary of support services for innovation offered by each of the five answered ULs. A red cell means "no". Empty cell means "not answered". Technical, legal, networking and guiding support types can be described as basic level support, whereas funding support is rare and hence clearly a high level type of support.

UL	Technical support	Legal support	Funding support	Networking support	Guiding	Other
Callio		Yes	Yes	Yes	Yes	
Äspö	Yes	Yes		Yes	Yes	
Freiberg	Yes	Yes		Yes	Yes	
Khlopin	Yes		Yes			
Ruskeala	Yes	Yes		Yes	Yes	

At present, constructive relations exist between the Karelian Research Center and the owners of the Ruskeala Mining Park, the most famous object of its kind in Russia. Innovative work in the park is carried out jointly with the owners of the park and their employees. The issues of safety of using underground and open mining space are addressed together. It is assumed that the work will be expanded to other owners of the underground space (museums, laboratories) using the example of modern cooperation in

the Ruskeala Mining Park (Notice by Ruskeala at UL2). This cooperation between the Russian partners might be intensified and further develop to a customer service support. The absence of legislation in the field of the use of underground space in Russia implies the development of measures for the safe use of such space in each individual case.

3.3 Current practices of the ULs reagarding IPR (Question UL.3)

The Question UL.3 was: "What are the current practices at your UL concerning IPR (Intellectual Property Rights)?". The options from which to choose were:

- No policy
- Innovator has all the rights
- UL gets some rights
- UL has all the rights
- Other: _____(which) _____

It appears that none of the five ULs has an official written policy for dealing IP rights. However, the answers are a bit vague about this. Äspö recognises that the IP rights are in all cases owned by the innovator itself (customer). Innovations financed by SKB (owner of Äspö) are always owned by them, including IPR. It is not clear which regulations exist for jointly financed research projects. The missing funding support for customers (see Table 2) implies that joint research cooperation are not commonly realized in Äspö. Ruskeala recognizes this in some cases. One UL follows a model where the IPR are shared in some extent between the innovator and UL (Callio). This shows that Callio has experiences about jointly financed R&D projects (see Table 2). Another UL solves the issue on case by case (Khlopin). Ruskeala states that the IPR rights may be completely owned either by the innovator (as referred to above) or, in some cases, completely by the UL. This may or may not be exactly the same model as what Khlopin follows. According to Freiberg, they do not have any IPR policy, which to some degree correlates to the missing funding support in Table 2. The answers are shown in Table 3.

Table 3. A summary of current practices of IPR regulations by each of the five answered ULs. A red cell means "no". An empty cell means "not answered" or "see 'Other'".

UL	Written policy	Innovator has all the rights	UL gets some rights	UL gets all the rights	Other
Callio			Yes		
Äspö		Yes			
Freiberg					No policy
Khlopin					Solved individually (i.e., depends on the case)
Ruskeala		Yes (or UL gets all the rights)		Yes (or the innovator gets all the rights)	

3.4 Handling of customer's sensitive data and material: NDAs or no NDAs (Question UL.4)

A Non-Disclosure Agreement (NDA) is a legally binding contract that establishes a confidential relationship between at least two parties, such as the customer (innovator) and service provider (UL). With a signed NDA the different parties agree that sensitive information (sketches, technical drawings, etc) may be shared between them without a risk that the said and showed information (e.g., data) is made available to any others. Hence, the NDA protects sensitive information of either or both parties from disclosure to outsiders. The NDA outlines what types of confidential material, knowledge, or information is shared, or may be shared, between the parties. The UL.4 question focused on the NDA related issues. The asked subquestions were:

- Does the UL requires /accepts an NDA from their users?
- How the UL needs to deal with sensitive material of the facility users?
- How do the users need to deal with sensitive material from the UL or other users?

According to the answers, all five ULs accept NDAs if the project or customer has need for that. However, none of the ULs require them. This is likely related to the fact that they are the local service provider, while the user is more often than not the sole innovator and thus the proprietor of sensitive information. If the project is a cooperation project than a customer's in-house project, most if not all of the ULs appear to be flexible in seeking

solutions that work best for the given situation. With regarding the question how to deal with sensitive material (e.g., with data from database), the UL customers have to agree on special contracts or agreements (Äspö). Table 4 summarizes the NDA policies of the five ULs.

Table 4. A summary of different approaches to sensitive information and relationships between the ULs and their users such as project partners and paying customers (e.g., commercial companies). Note that regarding NDA policies, the differences between ULs appear to be small and possibly relate more to wording/answering styles of individual ULs than true diffencies. A red cell means "no". Empty cell means "not anwered" or "see 'Other'".

UL	NDA always required	NDA accepted if there are sensitive data	Other
Callio		Yes	*
Äspö		Yes	
Freiberg		Yes	**
Khlopin		Yes	***
Ruskeala			****

*Callio writes NDA agreements with their Customers and Partners (e.g., for joint-development projects). Sensitivity issues concerning materials will be dealed case by case with facility users and in accordance with the operating procedures of the local mine operator (Pyhäsalmi Mine Oy). However, the projects and NDAs also need to be in accordance with the Finnish Law (especially The Mining Act 621/2011) and The EU's REACH Regulation system (for the Registration, Evaluation and Authorisation of Chemicals). **Freiberg accepts NDAs if they are feasible with the general operation of the UL and the research topic is such that a NDA is needed between the partner/customer and UL. *** Khlopin states: due to the limitations associated with the specifics of the activities of our organization, and the location of UL in the metro, which is a strategic object, the issues of non-disclosure agreement are resolved individually. ****Ruskeala favours a model where the relations between them and the project (partner?) are primarily based on a cooperation agreement. However, commercial agreements (NDAs with the customer?) are acceptable in the future (or when the project goes to commercial stage?).

3.5 Experiences of the ULs concerning innovation and R&D (Question UL.5)

The last question directed to the ULs inquired what type of experiences they have from their current practices regarding innovation and research in their facilities. This question also gave room for describing miscellaneous topics related to innovation, research and customer–UL relationships. Each UL is dealt below separately in the same order as in the previous tables.

Callio

Callio's innovation process can be summarized as follows:

1. Interpreting the business strategy together with their partners/companies/ research institutes
2. Assessing feasibility of the objective
3. Analyzing the cause of the problem or common goal to be achieved
4. Recommending and/or innovating a solution
5. Formulating a scope of work
6. Progressively elaborating the scope of work
7. Executing the project, validating and initiating actions; monitoring performance along with project development
8. Ensuring that the strategic objectives of Callio are met
9. Ensuring that the strategic objectives of the partners/companies/research are met and that the project/solutions/PoC's are fit in 100% to the cause of the problem/goal
10. Sharing best practises and learnings

In this model, innovation becomes more central to the Callio project manager's work in helping partners/companies/research institutes to meet their strategic objectives. The project manager must actively seek ideas that adds value throughout the project life cycle to ensure that the result is achieved. This is preferably done in **joint-innovation mode.**

Äspö

The Äspö UL has 30-years of experiences about innovation management relating to R&D projects. For 10 years they have also used an open research platform **Nova FoU** developed by a local municipality of Oskarshamn for R&D purposes. According to Laaksoharju (2016), Nova FoU (R&D) was the research platform at Nova that was a collaboration between Swedish Nuclear Fuel and Waste Management Co (SKB) and the municipality of Oskarshamn. Nova FoU facilitated external access for research and development projects outside the nuclear business to the SKB facilities, data and competences in Oskarshamn. The aim of Nova FoU was to create local and regional spin-off effects in favour for the society and business. Nova FoU provided an access to the Äspö Hard Rock Laboratory (Äspö HRL). Laaksoharju & Oscarsson (2017) provided more information about the Nova FoU open research platform. Today the access and innovation handling is provided by SKB

and the municipality organisation Atrinova is handlig the possible spin-off and business development effects from R&D at Äspö HRL.

Freiberg

An innovation management at the TU Bergakademie Freiberg runs among others through the start-up network "Suxeed" which supports and advises spin-offs especially in economic and public relations issues. Spin-offs can for example be established from research projects which are further supported by the institutes of the TUBAF. Spin-offs can also result from research projects which used the "Reiche Zeche" for research and development. Further offers of the Saxeed are workshops, courses and information material for project development and for business start-ups.

One example of such a spin-off was the founding of a start-up company as a result of the Real Time Mining project, in which methods and techniques were developed and tested in the research and education mine "Reiche Zeche".

This innovation management is done in cooperation with the institutes and Saxeed, but is not directly linked to the mine itself. In future, tools of this innovation management can be implemented as well, but further collaboration with Saxeed in terms of economic issues is advisable.

Khlopin

Khlopin UL did not comment to the UL.5 question.

Ruskeala

The Ruskeala Mountain Park is the most famous object of its kind in Russia. Innovative work in the park is carried out jointly with the owners of the park and their employees. Innovation work addresses the issues relating to safety of using underground and open mining space. It is assumed that the innovation work will be expanded to other owners of underground spaces, such as to certain museums and laboratories. The modern cooperation model used in the Ruskeala Mountain Park may hence be used as a blueprint for similar development elsewhere. It is also noteworthy that the current legislation in Russia does not yet cover the use of underground space. Therefore, the protocols and best practices developed in Ruskeala are of interest elsewhere in Russia. Moreover, the Ruskeala Mountain Park UL stresses that unlike the existing mining enterprises that

manage technology and economics of mine development by using extremely expensive software, different solutions needs to be found for projects that based on long-term use of underground space, for example, as an UL, underground museum, storage facility or test site. Indeed, the needs of such projects and enterprises are closer to the needs of civil construction projects.

At present, the Ruskeala Mountain Park uses photogrammetric methods to create real-world like 3D models of underground and other open spaces. They also develop new technological solutions to improve these methods techcically, including something they define as “an innovative technology for photogrammetric shooting of small underground space“. Innovative models for monitoring the stability of the mining space are also developed. In these regards, two patents obtained during the BSUIN project (together with KGHM CUPRUM) are already in use, mostly underground. The Ruskeala Mountain Park has created detailed models with an accuracy of 1 to 2.5 mm of individual batches of both open and underground spaces. Data generated by using all these methods form the basis for decisions and recommendations for the safe operation in underground facilities and for ensuring a safe visit for people in historical mine workings.

The above-mentioned photogrammetric methods under development form the basis of the information model of the museum’s “mountain space”, which includes both open and underground spaces. This is done by using BIM and HBIM technologies. Herein BIM and HBIM refer to “Building Information Modelling” and “Historic/Heritage Building Information Modelling”, respectively. For additional reading, see for example Murphy et al. (2013), Dore & Murphy (2017) or Ewart & Zuecco (2018).

4. Conclusions and recommendations

4.1 Conclusions

The questionnaire of WP3.4 was sent to six ULs operating in the framework of the BSUIN project. The following summary is based on the answers of **Callio** Lab (Finland), **Äspö** Hard Rock Laboratory (Sweden), Reiche Zeche (**Freiberg**, Germany), **Khlopin** Radium Institute Underground Laboratory (Russia) and **Ruskeala** Mountain Park (Russia). The KGHM **Cuprum** R&D centre, Poland, did not answer to the UL questionnaire but to the customer questionnaire (see WP 3.3 Innovation Management report)

- Innovation management systems (UL.1)
    - **Callio, Äspö, Freiberg and Ruskeala** have a system for Innovation Management already in place
    - **Khlopin** is in the process of planning a system for Innovation Management
- Innovation support (UL.2)
    - **Äspö, Freiberg, Khlopin and Ruskeala** provide technical support
    - **Callio and Khlopin** provide funding support
- Intellectual Property Rights (IPR) (UL.3)
    - None of the ULs have an official written IP polices
    - **Callio** follows a model where the IPR are shared in some extent between the innovator and them
    - **Äspö** states that the IP rights are in all cases owned by the innovator itself (customer)
    - **Freiberg** do not has a IPR policy
    - **Khlopin** follows case by case model
    - **Ruskeala** states that the IPR rights may be completely owned either by the innovator or, in some cases, completely by them
- Handling customers' sensitive data and material (UL.4)
    - All five ULs accept NDAs if the project or customer so require. However, none of the ULs require NDAs themselves
    - Most if not all of the ULs appear to be flexible in seeking solutions that work best for the given situation
- Experiences & comments (UL.5)

- The experiences between different ULs vary, but it is only natural as they (i) use different types of innovation and research management systems, (ii) provide different types of services concerning innovation support, and (iii) differ from one to another concerning their IPR policies. However, all ULs appear to be flexible concerning NDAs
- **Callio, Äspö and Ruskeala** described their operation principles in more detail

4.2 Recommendations

BSUIN ULs meet in most circumstances the technical requirements and necessary fascilities asked by the customers and summarized as basic requirements in report on WP 3. In addition, Äspö, Callio and Ruskeala have already implemented a systematic approach to optimize their internal processes and services necessary for customer treatments regarding steps towards an active Innovation Management. This inludes also a realistic view on the available staff capacities to tackle customer necessities and wishes. All this is part of the first step, the SWOT analysis, of the systemetic approach to enhance innovation management described in report on WP 3. The next step would be a strategic decision regarding ULs targeted tole and profile in the innovation management process. All ULs have the capabilities to act as fascility provider or subcontractor. None of the ULs has currently all servrices and supports available to act as an innovation hub. To act as project partner or project initiator BSUIN ULs have to enhance their competencies, resources and services described in WP 3 report. To reach the desired new role in the innovation process ULs shall create a roadmap including key activities and services.

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Questionnaire

Section UL: Innovation management at your Underground Laboratory (UL)

Innovation management means finding new methods/approaches to utilise the usage of the existing underground facility. How do you deal with innovation projects in your underground laboratory? What is working well and where do you see challenges in the innovation management and what should be improved?

UL.1 Does the UL have a process for innovation management?

☐ Yes → proceed with UL.2

☐ No → Is the UL planning to have in the future a process for innovation management?

☐ Yes → proceed with UL.2

☐ No → proceed with UL.5

UL.2 Does the UL support / will it support innovative processes of their users? If yes, how?

	no	yes	
Technical support	☐	☐	
Legal support		☐	☐
Funding support		☐	☐
Networking support	☐	☐	
Guiding to other organisations	☐	☐	
Other		☐	which:

UL.3 What are the current practices at your UL concerning IPR (Intellectual Property Rights)?

No policy		☐	
Innovator has all the rights	☐		
UL gets some rights	☐		
UL has all the rights	☐		
Other		☐	which:

UL.4 Does the UL require /accept a NDA (non-disclosure agreement) from their users? How the UL needs to deal with sensitive material of the facility users? How do the users need to deal with sensitive material from the UL or other users?

UL.5 Experiences from practice, miscellaneous or explanatory notes?