Baltic Sea Underground Innovation Network (BSUIN)

Interreg Baltic Sea Region
EUROPEAN REGIONAL DEVELOPMENT FUND
EUROPEAN UNION
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Baltic Sea Underground Innovation Network

Delivery description	WP 2 activity 2.4	
Delivery Title	Organizational characterization	
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Symbols and Abbreviations

Abbreviation	Description
BSUIN	Baltic Sea Underground Innovation Network
FLB	Forschungs- und Lehrbergwerk (Research and Education Mine)
HRL	Hard Rock Laboratory
OAMK	Oulun ammattikorkeakoulu (Oulu University of Applied Sciences)
TUBAF	TU Bergakademie Freiberg
UL	Underground Laboratory
WBT	Web-Based-Tool
WP	Working Packages

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1 Introduction

The overall goal of the Baltic Sea Underground Innovation Network (BSUIN) is the development of a supporting service/organization which will help to present and offer the technology and capabilities of the involved underground facilities for scientific research and various business interests. These interests can include new underground production sites, production of thermal energy, and testing of geophysical and radiation detection and measurement instruments. With the help of a Web-Based-Tool (WBT) the BSUIN organization can assist potential customers and the underground facilities in their decisions and choices.

In order to develop the organizational structure and the web tool, the project is divided in several Working Packages (WP's) and activities. The aim of WP2 is to gather information from all underground facilities which can be used in further assessments and as the core for a data base for the WBT (Figure 1). This report is focused on activity 2.4 (organizational characterization) within WP2.

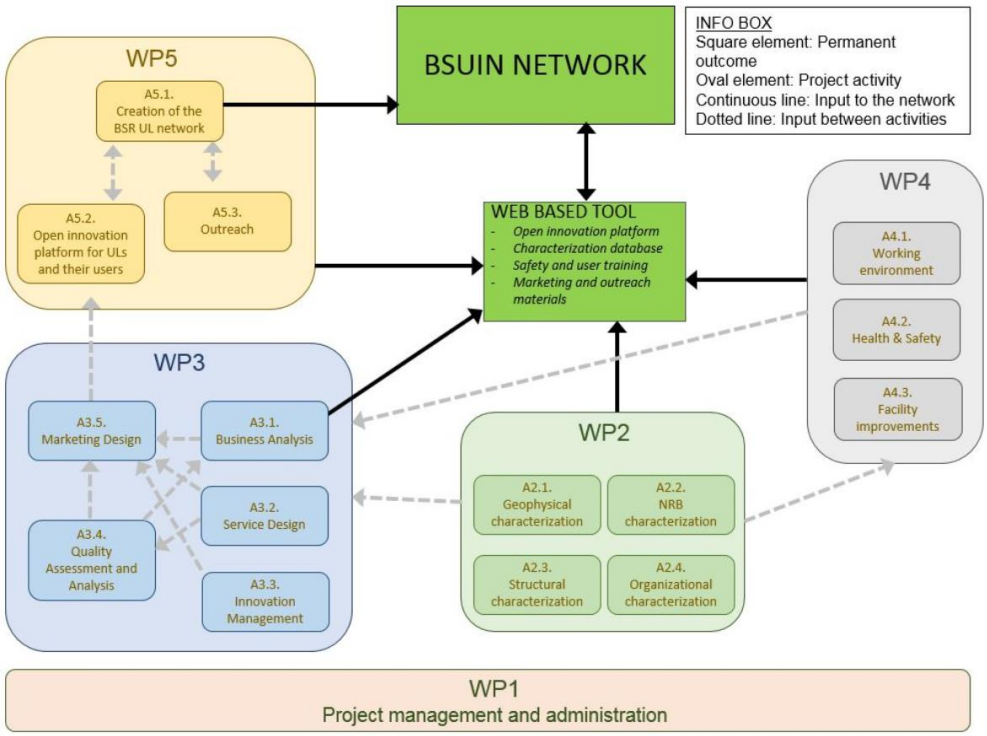


Figure 1: Activities in the BSUIN project

1.1 Activity 2.4 Content Description

The aim of activity 2.4 is the mapping of the prevalent organizational situation of the partner's Underground Laboratories (UL). The BSUIN ULs landscape varies in terms of services and thus, the technical and organisational resources. In order to be in a position to offer external customers a coordinated level of service after the project has been completed, these resources are examined and processed as part of this activity.

The survey of activity 2.4 will focus on the prevalent ULs

1. Infrastructure/Technical Equipment + Operational Procedures
2. Current Business Model

The data are gathered by creating a questionnaire for each part, which will be accompanied by workshops with the UL partners in order to describe and analyse the current structure of the ULs. The gathered data are finally processed and compiled into a comprehensive document, which is made available to the subsequent Working Packages (WP) by the BSUIN database.

Part 1 focuses on these sample issues:

- IT (data transmission, computational resources, data access, data security)
- Telephone, radio transmission
- Energy (electricity, compressed air, fuels)
- Water supply
- Ventilation
- Transportation capabilities
- Gas monitoring
- Emergency
- Workshops
- Mine monitoring

Existing research facilities & underground laboratories

- Accessible scientific equipment
- Available services (drill core production, mine surveying, site expansion, …)
- Accessibility

Organization

- Scientific/Mining specialists, Management structure
- Involved authorities
- Infrastructure accessibility for external partners and degree of free movement
- Opportunity for permanent / temporary installations
- Operational expenditures for UL activities

Environmental conditions

- Working conditions (light, temperature, humidity, …)
- Mandatory occupational health check / certificate
- Health monitoring (exposimeters, …)
- Safety instructions/regulations (compulsory oxygen self-rescue device, …)
- Gas action plan/explosion protection measures
- Hazardous substance restrictions
- Environmental restrictions

Within part 2 service design/exploration phase workshops are facilitated in order to describe and analyse the current business models of participating ULs by using service design. Th business model canvas consists of nine (9) building blocks: customer segments, value propositions, channels, customer relationships, revenue streams, key activities, key resources, key partners and cost structure. This activity will lead to service design/creation phase in WP3, Activity 2.

Output Description for activity 2.4

By building a structured "inventory" of the involved underground mine and lab sites, the project consortium will be able to develop a clear plan on potential partners, services and marketing instruments.

The first milestone is the set-up of a comprehensive questionnaire. This will allow covering all capabilities of the individual sites, while allowing for comparability by choosing a standardization approach.

The second milestone is the processing of the questionnaire by all UL partners plus the completion to a comprehensive document by TUBAF.

The characterization information will be made available with the BSUIN web-based tool.

Milestone meetings of WP2 will present business model and value proposition canvases of the ULs, workshops, explanations of different industrial contexts of the ULS in the network, and a shared understanding of existing business models.

2 Questionnaire and Business Model

As part of WP2.4 a questionnaire inquiring about key topics in legal situations, operating situations, health and safety, installations, accessibility, available workshops and laboratory facilities have been developed. The questionnaire is designed to address a wide-based overview of the above topics. Special attention was given to legal issues to be considered esp. in research work and in mining law of the different countries where the facilities are located.

A template of the questionnaire is attached at appendix. Along with the questionnaire, the canvas template summarizes and describes the following topics:

- Infrastructure
- Offerings
- Customers
- Finances
- Revenue stream

A basic introduction to the model is given in the following quote:

"The business model canvas is a strategic management and lean startup template for developing new or documenting existing business models. It is a visual chart with elements describing a firm's or product's value proposition, infrastructure, customers, and finances. It assists firms in aligning their activities by illustrating potential trade-offs."

An article on the business model canvas can be found in Wikipedia:

https://en.wikipedia.org/wiki/Business_Model_Canvas

A blank Canvas questionnaire can be found in the appendix (A3 Canvas Business Model Questionnaire).

2.1 Development of the Questionnaire

Development of the questionnaire for activity 2.4 began in November 2017 by the reformulation of activity 2.4 from activity 2.3. Various relevant topics had been discussed for the questionnaire, and an internal questionnaire for partners of the TU Bergakademie Freiberg (TUBAF) research mine Reiche Zeche was evaluated.

A first draft of the questionnaire was discussed with Jari Joutsenvaara (Oulu University/Callio Lab) in December 2017, which raised awareness of differing point of views on individual questions, as each project partner and the Underground Laboratory (UL) expresses their personal and individual background. Questions were then reformulated for a more general understanding and existing questions were amended for a second and third draft.

At the beginning of 2018 the resulting third draft of the questionnaire underwent a revision by Katrin Jaksch (GFZ Potzdam), Panu Jalas (Oulu University) and Markus Laaksoharju (SKB) and was tested internally by the mine manager of TUBAF after further reformulation and finalization. The finalized Questionnaire was sent to the project partners on January 31. The questionnaire was then allotted time through early March 2018 for its first general responses and for presentation at the road show meeting at the Reiche Zeche Freiberg. This first response from the project partners was then used in preparation of the data collection tour as further input to the questionnaire. At the road show meeting at the Äspö Hard Rock Laboratory (HRL) in June 2018 the first conclusions had been presented.

Information for the Canvases Business Model was gathered in workshops and interviews with participants from each UL during the spring of 2018.

Unfortunately, we did not receive a response on the TUBAF questionnaire from the Khlopin Institute, even after repeated requests. Information on that location could not be included.

2.2 Data Collection Tour

In addition to the questionnaire a data collection tour was organized by TUBAF and the University Oulu. The goal was to further clarify remaining/open questions of the first questionnaire and gather more detailed information on each UL, as each facility is unique in its conditions or in the individual experiences of its operators.

The data collection tour began in March 2018 at the road show meeting in Freiberg (Figure 2 shows the meeting in the underground seminar room of the TUBAF UL). After that meeting KGHM Cuprum, SKB's Hard Rock Laboratory (HRL) in Oskersham, Ruskeala Mining Park in Karelien, the Khlopin Institute in St. Petersburg and the Callio Lab at Pyhäsalmi were visited. At each location individual objectives and the first answers to the questionnaire were discussed.

Figure 2: FLB Reiche Zeche Seminarraum (seminar room at the TUBAF mine, picture: Jari Joutsenvaara)

The data collection tour gave excellent insights to the existing ULs and their boundary conditions. It was of utmost importance for the participants to gain direct insight into the locations as this helps to clarify open questions and to give a full picture of the capacity of each location. Details in the answers given to the TUBAF questionnaire could sometimes only be understood in view of the visit to the location itself.

2.3 Comparison of Answers to the TUBAF Questionnaire

It is essential to store the collected data in a clearly and well-structured way to enable, at a later time, based on customer requests, the selection of most suitable underground facility for comprehensive satisfying of the requirements of potential customers.
The data storage system must also be expandable because additional parameters will be added in future. The questionnaire and the data it contains it should be handled as a snapshot of the current conditions in every facility. With each new customer request, the questionnaire will have to be expanded by further questions which have not been considered before.

Up to the present, the data is stored in an access database which is subdivided in different tables for definition of facilities, topics and questions, and answers to the defined questions. In this way the data storage structure can easily be extended at any time further. With this method of data storage, it is also easy to add the data of additional facilities.

The collected data was not intended for the creation of use cases, because it must be expected that every research inquiry will be absolutely unique, which would yield as many use cases as inquiries. Therefore, the evaluation of the collected data is just showing the bandwidth of the different considered parameters. The Interpretation of the data collected by means of the questionnaire turns out to be complicated and it is therefore not feasible or useful to drive a conclusion based on the questionnaire on the status of an underground facility due to huge differences among them.

The following tables show an excerpt of the collected data and their inhomogeneity. For example, question 3.1 asks for relevant authorities. The answer to this question for the Forschungs- und Lehrbergwerk (FLB, Research and Education Mine) “Reiche Zeche” is that the Saxon mining authority is a bundling authority for all licencing matters. All other authorities are contacted via the mining authority, for which reason only one authority needs to be contacted. This bundling authority is unique among the considered facilities and may make licences/approvals quite easy. Therefore, this authority structure can be considered highly beneficial. With the other facilities involved in the BSUIN project permits have to be obtained from various authorities depending on the location of the facility and of course the project. n the following tables, some cells are coloured to display similarities and differences between individual facilities. Grey indicates differences currently classified as maximum. This classification is based on the current assessment by the editors. Yellow indicates significant topics that have a special position due to specific national regulations or regional characteristics.

In the course of further data collection, which will also be based on inquiries from potential research partners, continuous adjustments have to be expected.

Table colour legend:

- Distinguishes two answers with maximum differences
- Marks more advantageous conditions
- Marks less advantageous/disadvantageous conditions

Table 1: Legal Situation (selection)

	Callio	Äspö HRL	Karelien research institute	KGHM	Reiche Zeche
1.1 Status of UL	Callio – Mine for Business facilities (not a single lab!) Brand owned 100% by town of Pyhäjärvi	Äspö Hard Rock Laboratory is a part of the Technology department of Swedish Nuclear Fuel and Waste Management Co. (SKB)	Scientific laboratory in the Departament of complex scientific investigations of the Karelian Research Centre of Russian Academy of Sciences	coorperation under public law, active mine; no UL	Cooperation under public law as part of University of Technology Freiberg
2.1 Owning Institution	Underground facilities and land owner is Pyhäsalmi Mine Oy; Callio has an exclusive right to re-use, rent & lease	100% owned by the Swedish Nuclear Fuel and Waste Management Co. (SKB)	Karelian Recearch Centre (Institute of geology) Russian Academy of Sciense	In case of build UL facility, KGHM Polska Miedź S.A. company will be the owner	State of Saxony, Ministry of Science and the Arts; Wigardstraße 17; 01097 Dresden; Germany
2.6 Type of contracts	Duration license agreement; Reserarch contracts; Facility renting agreements; Leasing agreements; Service agreements	• Data Delivery • Water sampling and analysis • project support • Full undertaking Total solutions • Support to client´s research/testing • Rental of instruments and equipment	depends on contract, no limits	Commercial contract; Research contract	
3.1 Relevant authorities	Callio (Pyhäsalmen Kvanttikiinteistöt Ltd); Town of Pyhäjärvi; Pyhäsalmi Mine Ltd	When preparing each individual research case, it is evaluated if special permission needs to be sought. This is always handled by the UL (SKB).	Scientific investigations have no licensing procedure. In the case of use of analytical equipment some accreditation is needed like for similar laboratories in Russia.	KGHM Polska Miedź S.A. M. Skłodowskiej-Curie 48 street, 59-301 Lubin, Poland; Polish/ English	Saxon mining authority is a bundling authority. All other authorities are contacted via the mining authority; Applicable language is German.
3.3 Relevant law jurisdiction		The Quality Management System at the UL handles all relevant Swedish legal requirements	In general basic law is named “On underground resources” We are paying attention to old underground space which now is not used for extraction of ore. In that field the legislation in Russia is completely undeveloped.	Polish Geological and Mining Law , Water Law and many more, mostly available only in polish language.; Most of the required legal acts and ordinances can be found http://www.wug.gov.pl/prawo/wiedza	Federal Mining Act (BBergG), General federal mining ordinance, saxonian mining ordinance

Table 2: Operational Situation

	Callio		Äspö HRL		Karelien research institute		KGHM		Reiche Zeche	
4.1 Responsible organizing permissions	UL operator		UL operator		UL operator		UL operator; research partner		UL operator	
5.2 Competitive activities	Education (e.g. MineTrain project); Tourism (under planning); RDI (e.g. Normet Ltd); Production (e.g. growing and natural resources); Energy (e.g. Energy storage project); Data Center		Yes, coordination with other projects, service activities, visitors, educations		at the moment no		Education, production and technology development		Primarily education and tourism; Performance of blasting activities limited to certain time slots a week; Person/material transport can experience waiting periods on daily operations if not announced in advance.; The closure of certain sections/pathways of the mine for running experiments is limited to certain spots	
6.2 Language	Finnish and English. Pyhäsalmi Mine has also Swedish speaking employees as a native language.		Swedish or English		Polish and English.		Working language is Russian		german according §2 saxon mining ordinate, translator requested in case partner is not capable to communicate in german	
6.3 Administrative procedures	once	dayly	once	dayly	once	dayly	once	dayly	once	dayly
	Safety traning, personal ID card, safety gear and equipment	Log in and out to the facility	Safety traning, personal ID card/keycard, RFID tag	Appointed coordinator will always assist the applicant	common safety requirements	No special requirements	Safety traning, personal ID card	Check in, check out with personal ID card	Briefing occupational safety, escape routes	Subsurface presence registration

6.4 Fixed schedules	Daly, two shifts	Mo - Fr		dayly	blasting only Monday & Tuesday, Wednesday-Friday later presence possible
6.5 Available technical facilities		office space, locker rooms, neaby contractor's barracks with lockers, wc, shower and kitchenette are located.			
6.6 Is it possible to move independently within the UL	yes	yes	yes	no	yes
6.8 Transportation	mine vehicles	mine vehicles	site to small, no transportation	mine vehicles	Railway tracks, railway for material and person transport ; Transportation provided by previous announcement of service required

Table 3: Health & Safety, installations, accessibility, workshops

	Callio	Äspö HRL	Karelien Research Institute	KGHM	Reiche Zeche
7.3 Environmental restrictions	Materials and substances used at the industrial zone of Pyhäsalmi Mine must comply with the requirements of the Pyhäsalmi Mine.	approved by UL operator	no special restrictions		All substances affecting ground- or surface water are critical. Need to be processed and cleaned before they leave the mine
7.4 Equipment restrictions	CE certification required Generally for tools and machinery items must comply with the CE standard. For location specific conditions other standards can also be requires (e.g. atex	CE certification required	no limits for the moment	CE certification required Genehmigung der Bergbehörde für den Einsatz elektrischer Geräte erforderlich,	CE certification required Periodical check of devices by the external association for technical inspection according to the accident prevention regulations
8. Communication & IT	Radiophone, Telephone (fixed), Sonera mobile, VOIP (Skype) optical fibre, WiFi M-Solutions Ltd. Is also capable of providing server resources for external users with a cost F-secure; SLL	DECT telephones fibre network Sicada is SKB:s data network . It is possible to request data from Sicada to an additional cost firewall, back ups possible	Different kind of modern communication optical cable Cluster for high speed communication	Telephone and radio-transmission	telephone (analogue) depending on location in mine (fibre cable, leaky feeder) avaiable computrepower up to high performance, data storage, data base university network with back ups for six weeks, data mirroring on two physical sites, remote data access to prevent unauthorized access
9. Water management	Freshwater, technical dewatering	fresh water, not drinkable, technical dewatering, pump stations between pits, pumps Flygt 2400 with 2 pumpes fitted, total pumped water is 420000 m^3/a, sedimentation pit with surface screen to prevent any oil to enerr the baltic sea	fresh drinking water for restaurant, natural dewatering, no treatment	water avaiable, not drinkable, technical dewatering, System of permanently mounted steel pipelines within long-term functioning workings. And removable watering system within mining panels/districts	fresh water supply throughout mine, not drinkable natural dewatering via Rothschönberger dewatering adit in a depth of 230 m below surface, no pumps required for mine operations not necessary, Research partner is responsible to treat

					waste water within its own research installation if necessary
11 Energy	3 x 110 kV to the area (Elenia); 6000 V to the Mine European standard 400 VAC CEE, 230 VAC Schuko	Standard levels 400/230 V; Power plugs are CEE-type and SCHUCKO 10 – 125 A; System TN-S 400/230 V separation of underground supply and elevator 3 alternative high voltage connections giving a very high degree of redundancy mobile compressor can be provided	surface 220-380 V; underground only 24 V, no compressed air		400kVA installed, 200 kVA still avaiable, IT net, operating voltage 400 V, via isolating transormer 230 V at each research site 400/230 V 1 Compressor with Oil / Water seperator, Water seperator additionally in each pipe underground
13. Accessibility	Shaft hoist (Timon kuilu) 1410 meters (< 3 minutes); Ramp (vinotunnel) 11 km to the bottom of the mine. mine vehicles	Elevator Performance 2 tonnes / 20 people; Max 5 m/s; Raise borer hoist shaft, 4 metre in diameter. ; Size of tunnel gate W*H 4,35*4,5 m 2t/cage 20 persons 4 m diameter of shaft Size of tunnel gate W*H 4,35*4,5 m; cars, pick up trucks, loader	tunnel entrance, lenght 300 m, no need for transportation at the moment	mine vehicles	Shaft hoist, dimension 0,8 x 1,5 x 2m; Below shaft hoist 6m x 0,94m, limit 2t each cage or 6 persons 2 t/cage 6 persons 0,8 x 1,5 x 2m 6m x 0,94m hanging below cage 2 locomotives, track 600mm, width of galleries 2,2 x 2,2 m

As a result the questionnaire a number of important factors describing the individual facilities emerged. In particular, factors concerning infrastructure, including the possibilities for using workshops of individual facilities, legal boundaries, the accessibility of the facility and the language issues are investigated. An evaluation of the questionnaire determines that every facility is differently positioned as a prospective research environment.

As already mentioned, an analysis of the questionnaire can't evaluate of what type or kind of a research project can be done preferably on which facility. This decision depends on every unique research project itself. Based on the questionnaire, however it will be possible to generate a portfolio of the BSUIN consortium, which publishes the available bandwidth of opportunities for research tasks in underground areas of the associated facilities and how it could fit into existing legal structures and the infrastructure. For example is it possible to discuss schedules that can be shifted to fit the terms and conditions of the mine, but if the research project requires equipment that does not fit the limitations of the given infrastructure, the project cannot be executed without further ado. In particular the infrastructure and means of transportation can be seen as vital points, as the size of ramps and shafts cannot easily be changed to allow for lagerr equipment, which than may have to be disassembled.

2.4 Summary of the Most Important Points

In the following a point-like summary is given as overview of the most important topics. This is only an excerpt on information on infrastructures, accessibility and legal issues.

Available infrastructure

- TUBAF
  - shaft hoisting with 2 cages, up to 2 t, dimension each cage 0.8m x 1.5m x 2m, up to 6 persons per cage
  - underground transportation via 2 locomotives, tracks 600 mm, width of the galleries 2.2m x 2.2m
- KGHM
  - mine vehicles of all sizes
  - shaft transportation not specified
- Pyhäsalmi Mine Oy/Callio Lab
  - shaft hoist (3 minutes to get on 1410 m level)
  - 11 km ramp to get to the lowest level
  - all sorts of mine vehicles for personal and material transportation
- SKB
  - shaft hoisting up to 2 t, or 20 persons
  - size of underground galleries 4.35m x 4.5m
  - mine vehicles for material and personal transportation
- Karelien/Ruskeala
  - no designated transportation within the adit/drift as distances are small (300 m drifts)

Accessibility

- TUBAF
  - only a simple introduction is required for visitors
  - for working: mine fitness examination (retrievable at all medical health centres or company doctors)
  - otherwise no issues for guests -> mandatory guide who is familiar with the mine and speaks German, as German is necessary defined communication language of the mine
- KGHM
  - Health certificate, attest of the absence of any criminal record!
  - language polish and English (allegedly)
- Pyhäsalmi Mine Oy/Callio Lab
  - For more permanent underground work mandatory annual underground worker health checks
  - languages Finnish, Swedish, English
- SKB
  - languages is Swedish and English
- Karelien/ Ruskeala
  - visitors from other countries will be checked by the FSB
  - Visa issues?!
  - Language: Russian

Legal situation

- TUBAF
  - mine and research operates under German mining law in general
  - bundling authority which has to be contacted
  - official language at the mine is German
- Pyhäsalmi Mine Oy / Callio Lab
  - Currently active mine by law
  - authority at the town of Pyhäsalmi
- KGHM
  - Rudna is an active mine by law
- SKB
  - research mine by law under supervision of WEA (Work Environment Act regulating work safety)
- Ruskeala
  - no law for research mines
  - analytical equipment needs accreditation

3 Business Models

The Business model describes the logistics of how a company intends to make money and the rationale of how a company/an organization creates, delivers and captures value. The business model canvas, which has been used, is a tool for describing, analyzing and designing business models. (Osterwalder & Pigneur 2010.)

Complete summary on the UL's business models can be found as appendix A 4 Summary WP2.4 Business models presentation as it was presented at the meeting in Äspö on June 18-20th, 2018. The business models of the ULs can be found on the links:

- CALLIO https://canvanizer.com/canvas/ryheruOzNzhLs
- CUPRUM https://canvanizer.com/canvas/rrvzI84LYLFrO
- KHLOPIN https://canvanizer.com/canvas/ruM9PPsSEoIw3
- REICHE ZECHE https://canvanizer.com/canvas/rtzfJcmp6HCUv
- RUSKEALA https://canvanizer.com/canvas/r67K4PaZPJavl
- SKB https://canvanizer.com/canvas/rTIAONMBsV9ju

Important findings of the business models of the ULs:

- **Paying customer segments are few in number**
- Personal relationships, conferences, publications are important
- The most important customer segments are universities and research institutes
- **Financial resources are generally scarce**
- **Human & intellectual resources are strong**
- Business functions are not very often mentioned as activities, e.g. marketing, communication
- **Partners are known well**
- Revenue streams from paying customers are not substantial
- Fixed costs are significant

➔ for all Partners

4 Conclusions and Recommendation

The answers to the TUBAF questionnaire illustrate the huge variety of available facilities and shows that the band width for possible projects is quite wide. But legal issues have to be clarified further on, so that research applicants can be presented with a clear picture of what is needed and required. Thus, further data should be made available within the database, resulting in a database which can be updated any time to provide the organization with the newest and updated information (in case approval procedures change or the mine infrastructure is modernized and so on).

Providing legal information would of course be a counselling step after obtaining required basic information from the research applicant on the aimed research project and its goals and possibilities. Therefore, it will be necessary to equip the BSUIN organization with a questionnaire for research applicants. This can be put on the webpage of the organization and should provide enough information on the project to allow further discussions and council.

As an example, the iMine questionnaire of the European Union's EIT RawMaterials project can be used as an archetype for a BSUIN questionnaire. The full iMine questionnaire can be found in the appendix. While the iMine questionnaire also emphasis on a possible positive feedback for the research location and requests the research applicant's response on that, the questionnaire for the BSUIN network might not. The reason for that is, that in a first setting of questions the location is not finalized and the research applicant could only hardly answer on that issue. Depending on the council and decision of the BSUIN network organization, suggestions on how the research applicant can improve and aid the UL can be given.

4.1 Conclusions concerning the Business Models of the ULs

In the following the results from the business models are summarized.

STRENGHTS

- Human & intellectual resources are strong
- Personal relationships, conferences, publications are important
- Partners are known well

WEAKNESSES

- Paying customer segments are few in number
- The most important customer segments are universities and research institutes
- Financial resources are generally scarce
- Business functions are not very often mentioned as activities, e.g. marketing, communication
- Revenue streams from paying customers are not substantial
- Fixed costs are significant

Best practises from different ULs:

- Important long-term data set / documentation for R&D
- Long-term relationships with certain customer segments
- Openness towards different stakeholders incl. the general public
- International co-operation, the ULs operate internationally
- Close contacts with research institutes and universities
- Tourism as a business
- Educational export as a business
- Strategic thinking & plans
- Active marketing of ULs resources
- Role of an intermediator for services

Challenges concerning the business models of the ULs:

- The vision for the future; strategy
- Attracting new paying customer segments
- Finding new business opportunities and services
- The cost structure is heavy
- Organisational system/structure is complicated
- Customer understanding; understand the business of the customer
- Commercial customer relationships could be more actively strengthened
- Customers should be asked for feedback to improve ULs operations

Recommendations

- Benchmarking what has been done in the similar ULs globally: what are they engaged in?
- What is/could be the competitive advantage of the BSUIN network?
- How can the expertise of the whole BSUIN network be used when creating new business?

4.2 Suggestions for a Questionnaire for Research Applicants

In the following a brief overview is given over suggested questions for research applicants. A concrete questionnaire has yet to be developed based on further investigation on the possibilities of all ULs. The main emphasis of the questions is to evaluate which UL could be feasible for the project depending on the research itself (geophysics in sedimentary rock or metamorphic rock) and the required infrastructure as temporary criteria for exclusion.

1. Description of the research project
   - 1.1. What field of research will be conducted and what will be the content of the research project?
     - Field of research? Mechanical engineering, physics, geophysics, geology?
     - What is being investigated?
   - 1.2. Explain a research plan and explain the supposed time schedule for the project and the possible runtime

2. Requirements for the project
   - 2.1. Describe the equipment that will be required (including dimensions) and the required means of transportation
   - 2.2. What type of IT infrastructure will be required?
   - 2.3. Describe the anticipated required space
   - 2.4. Describe the anticipated required power consumption for the project
   - 2.5. Are chemicals and/or hazardous materials included or needed?
   - 2.6. Are additional radiometric tools and/or tracers required?

3. Describe the funding of the project
   - 3.1. Is there funding from the EU and/or other organizations
   - 3.2. Is parallel funding possible?

4.2.1 Information Data Sheet of the TUBAF

The TUBAF uses a data sheet for research applicants to give information on their planned project and for the documentation. The data sheet contains several points to be answered by the research applicant.

1. General information regarding the project
    1.1. Title
    1.2. Description of the project (1/2 DIN A4 page)
    1.3. Responsible persons and contact information of this responsible person
    1.4. Address of the institution
    1.5. Are other institutions/organizations involved in the project
    1.6. Contact data of further persons who are involved in the project and allowed to give information

2. Geometric measurements and masses
    2.1. Measurements of required underground room (+ sketch)
    2.2. Measurements and mass of the largest single piece of equipment

3. Personnel requirements
    3.1. Responsible person for underground activity and contact information
    3.2. emergency numbers
    3.3. Number of persons working underground (under normal conditions and maximum)
    3.4. Do the persons have underground experience
    3.5. Do the persons obtain a health certificate
    3.6. Are workers from the UL required for the activity

4. Used/required installations and machinery
   - 4.1. Required immobile installations
   - 4.2. Required mobile equipment (mobile machinery but also chairs, tables and so on)
   - 4.3. Required hoisting machinery
5. Required material
   - 5.1. Required technical gases
   - 5.2. Is water required?
   - 5.3. Required liquids and chemicals
   - 5.4. Required lubricants
   - 5.5. Required electrical connections for
     - light
     - machinery
     - plug sockets
   - 5.6. Required phone and internet connection
   - 5.7. Is radio communication necessary
   - 5.8. Will radioactive tracers be used?
   - 5.9. Which waste materials can be expected (and volume of waste)?
6. Means of transportation that are required for the UL
7. Safety requirements
   - 7.1. Will access to the UL be limited and is it required to permanently lock the UL?
   - 7.2. Is a surveillance of the UL required (cameras, motion detectors)?
   - 7.3. Required fire extinguishing system
   - 7.4. Will flammable material be used?
   - 7.5. Usage of dangerous substances (list)

8. Requirements on mine ventilation
   - 8.1. Required minimum ventilation for unstaffed UL
   - 8.2. Required minimum ventilation for staffed UL
   - 8.3. Does the UL produce toxic gases (list)
   - 8.4. Does the UL lower the oxygen content of the air during operation
   - 8.5. Is Ex-protection (explosion protection) required?
   - 8.6. Is a minimized humidity required or a certain temperature?

9. Complete risk assessment

10. Timeframe
    - 10.1. Give a timeframe for the installation of the UL in the available underground room
    - 10.2. Is there a date for the start of the operations?
    - 10.3. Give a usage period for the UL
    - 10.4. Will the UL be operated fulltime?
    - 10.5. In case of usage in intervals, give information on the frequency and days of the week

4.3 Suggestion for a Search Algorithm

At the BSUIN meeting at the SKB Äspö HRL a suggestion for a search algorithm was presented (Figure 1). This search algorithm is only a suggestion for a tool to assist the BSUIN organization and to help in making a decision. The organization can use the information from the database and questionnaire for research applicants to consider the project, based on the goal of the project and the infrastructure it would require.

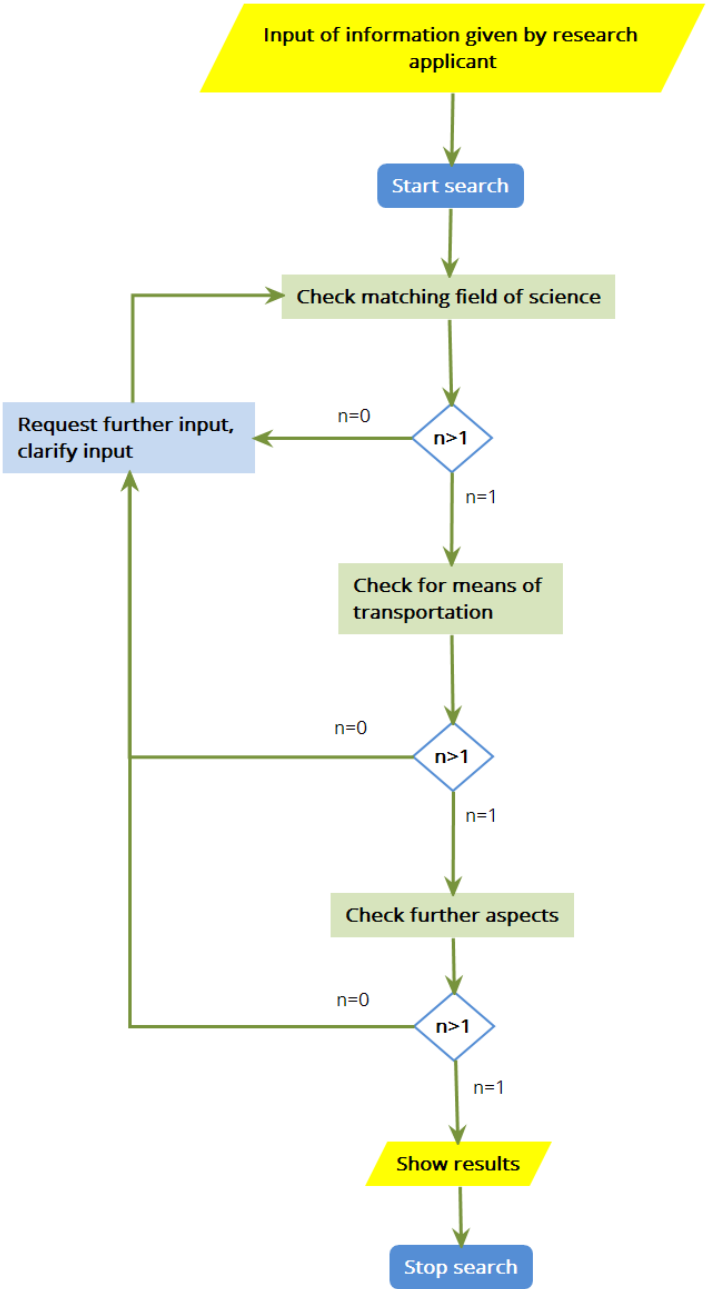


Figure 3: Suggested algorithm for possible support in decision making

5 Acknowledgement

This project has received funding from the European Union's regional development fund.

https://www.interreg-baltic.eu/home.html

http://bsuin.eu/

https://ec.europa.eu/

Appendix

A1 TU Bergakademie Freiberg Questionnaire

BSUIN Questionnaire
Activity 2.4

Created by TU Bergakademie Freiberg
Contributions by GFZ, UO, SKB
Version 1.0 – January, 31st 2018
Contact: David.Horner@mabb.tu-freiberg.de, +49 (0)3731 392150

Organization

Legal Situation

1. Legal form

1.1 Status of the Underground Laboratory (UL)

1.2 Jurisdiction

// Address

2. Business relationship

2.1 Owning institution of the UL

// Address

2.2 Authorized representative of the UL

// Address, contact person

2.3 Authorized management of the UL

// Address, contact person

2.4 Department for customer support

// Address, contact person

2.5 Relevant law jurisdiction for business relationships

2.6 Typical terms of contracts

(i.e. Duration license agreement, cession contract, contract research, …)

// Brief description

3. Research activities

3.1 Relevant licensing authorities for external research partners

(i.e. Bundling authority vs. separated authorities, …)

// Brief description, address, recognized language

3.2 Relevant institutions for operational documents

(i.e. occupational health / accident insurance, professional cooperatives, …)

// Address, recognized language, field of application

3.3 Relevant law jurisdiction for underground research activities

(i.e. mining law, …)

Operational Situation

4. Project Establishment

4.1 Responsible partner for organizing permissions from authorities and other institutions

// Brief description
☐ UL operator
☐ Research partner (applicant)

4.2 Who is titleholder of the granted permissions from authorities and other institutions?

// Brief description

☐ UL operator
☐ Research partner (applicant)

4.3 Which party is performing the installation of a new research laboratory on-site?

// Brief description
☐ UL operator
☐ Research partner (applicant)
☐ Subject to negotiation

4.4 Responsible partner for initiating tenders linked to research installations on-site

// Brief description
☐ UL operator
☐ Research partner (applicant)

4.5 Responsible partner for maintaining a third party research laboratory

// Brief description
☐ UL operator
☐ Research partner (applicant)

5. Management structure

5.1 Organization chart of your UL

// Departments, responsibilities, points of contact, planned changes

5.2 Are there competitive activities to research at your UL?

(i.e. tourism, production, education, …)

// Brief description, resulting restrictions

5.3 Do you have standard hourly rates for supporting research partners?

// Price list

5.4 Do you have standard rates for cession of UL owned equipment to research partners?

// Price list

5.5 Is a superior institution backing up the operation of your UL?

(i.e. in case of financial instability, severe malfunction or break downs of infrastructure, …)

// Brief description

5.6 Are any major maintenance projects planned at your UL in the short- to midterm?

// Brief description of objective and timespan

6. Operational Procedures

6.1 Requested documents for the establishment of new research activities / installations

(i.e. legal documents, documentation for the UL operator, recognized language, …)

// Brief description

6.2 Which is the communication language on site?

6.3 Which administrative procedures are requested on-site?

(i.e. safety training, personal ID card, …)

// Brief description

6.3.1 At date of arrival/departure

6.3.2 Daily

6.4 Which fixed schedules do you have on-site?

(i.e. daily worktime, fixed schedule for person / material transport, blasting …)

// Brief description, timetables

6.5 Which non-technical facilities are available on-site for external partners?

// Brief description

☐ Office space
☐ Storage space
☐ Locker rooms
☐ …

6.6 Is it possible to move independently within the UL after having received a site briefing?

// Brief description
☐ Yes
☐ No

6.7 Do external research partners have to provide an independent supervisor?

// Brief description

☐ Yes

☐ No

6.8 Which transport or support for transportation for equipment and personnel do you provide on-site?

// Brief description

6.9 What is the maximum number of people underground at your site?

(i.e. due to ventilation, evacuation plan, number of self-rescuers, organizational issues, …)

// Brief description

6.10 What hardware supply is located in the close vicinity to your UL?

(i.e. hardware store, building supplies, construction equipment rental, …)

// Brief description

6.11 What regulations do you have concerning disposal of waste material?

(i.e. compliance with a particular disposal plan, guidelines for hazardous substances, …)

// Brief description

6.12 Is a monitoring system for research activities available on-site?

(i.e. Parts and parameters of the UL, …)

// Brief description

☐ Yes

☐ No

6.13 By what means do you grant remote data access to external research partners?

(i.e. private/enterprise network, port restriction, VPN, …)

// Brief description, administrative process

6.14 Is it possible to install a proprietary monitoring system on-site?

// Brief description

☐ Yes

☐ No

6.15 Do you have a data disclosure obligation for certain information linked to research activities?

6.16 (i.e. person tracking, laboratory monitoring, …)

// Brief description

7. Health, Safety & Environment

7.1 Health monitoring

7.1.1 Is it necessary to create an occupational Health and Safety Document for a new research activity / installation?

// Brief description, recognized language

☐ UL operator

☐ Research partner (applicant)

7.1.2 Are there any mandatory occupational health checks/certificates for persons acting underground?

// Name / type of check / certificate, Possibility to receive such check / certificate, recognized language

7.2 Safety procedures

7.2.1 By which organizational instruments do you organize the protection of capital goods and the UL?

// Brief description

7.2.2 Which safety instructions / regulations - directly affecting external researchers - are in place at your UL?

(i.e. compulsory oxygen self-rescue device / exposimeter, gas action plan, emergency and rescue plan, …)

// Brief description

7.2.3 Accountable party for creating the Escape and Rescue Document for a new research laboratory

// Brief description

☐ UL operator

☐ Research partner (applicant)

7.3 Environmental Conditions

7.3.1 Restrictions on substance classes to be used within the UL

// Brief description, list, limitations

7.3.2 Limitations on groundwater impacts triggered by research activities

// Brief description, list, limitations

7.4 Limitations on equipment to be used within the UL

(i.e. fulfillment of certain specification/standard (CE), low background gamma radiation, …)

// Brief Description

Infrastructure

Installations

8. Communication & Information Technology

8.1 Voice communication

(i.e. telephone, radio transmission, voice over IP)

// Type of installed system, layout plan

8.2 Data transmission

(i.e. optical fibre, Ethernet, WLAN, … ; including tolerance for interference [single/multi/looped connection)

// Type of installed system, layout plan

8.3 Accessible server resources for external research partners

(i.e. computational power, databases)

// Type of installed system, layout plan

8.4 Data security mechanisms

(i.e. backup services, system redundancy, prevention of unauthorized data access)

// Type of installed system

9. Water management

9.1 Water supply (drink/fresh)

// Type of installed system, layout plan

9.2 Dewatering (natural/technical)

// Type of installed system, layout plan

9.3 Mine water treatment

// Type of installed system, layout plan

10. Air management

// Definition from checkpoints at dedicated locations
Mine ventilation
(i.e. volume flow, velocity, temperature, humidity, mine main fan (V, p), auxiliary fans, ventilation doors, separated ventilation sections, …)
// Type of installed system, layout plan

10.1 Gas monitoring

(i.e. surveyed gases, occupational exposure limits, actual emission exposure, …)

// Type of installed system, layout plan

11. Energy

11.1 Electricity

11.1.1 Transformationresources

(i.e. voltage levels, power plugs [N° + types], capacities, safety technology [IT, TT, …])

// Type of installed system, layout plan

11.2 Filtration capability

(i.e. balance of current / frequency spikes)
// Type of installed system, layout plan

11.2.1 Reactive power compensation

// Type of installed system, layout plan

11.3 Compressed Air

(i.e. filtering systems, one vs. separate lines for safety, …)

// Type of installed system, layout plan

11.4 Consumables

(i.e. diesel, gasoline, lubricants)

// Type of installed system, layout plan

12. Emergency Rescue Installations

(i.e. shelters, escape routes, oxygen stations, self-rescue devices, …)

// Type of installed system, layout plan

Accessibility

13. Please describe the accessibility for persons and material to your UL

(i.e. shaft hoist, cargo lift, ramp, …)

// Loads / dimensions / body type

14. Please describe the transportation capabilities within your UL

(i.e. condition of pathways, transport vehicles, …)

// Loads / dimensions / body type

Workshops

15. Which kinds of workshops are available and accessible to research partners on-site?

(i.e. maintenance, research)

16. Dimensions of the Workshops

(i.e. restrictions for experimental set-up)

// Brief description, length x width x height

Laboratory Facilities

17. Accessible research facilities to external partners

// Purpose, accessibility, equipment, dimension

18. Accessible scientific equipment

// Type, access conditions, price rates

19. Opportunity to set-up research installations permanently / temporarily within the UL

// Brief description

20. Access control to research laboratory

(i.e. locking system, camera surveillance, guardian , …)

// Brief description

21. Available services by the UL operator to external partners

(i.e. drill core production, mine surveying, site expansion, material surveillance [radiation characteristics], …)

// Brief description

22. Available scientific specialists (beyond regular mining engineers)

// Brief description

Date	Underground Laboratory	Editor	Signature

A2 EIT Raw Materials iMine Questionnaire

1. Available test and demo sites.

There are four types of test and demo sites available in Europe thru the iMine project.

- Open pit production mines
- Underground production mines
- Underground test mines
- Labs for various test purposes

The different mines have different characteristics like type of equipment, infrastructure and production methods. By answering the questionnaire below it will be much easier to find the right test and demo site and at the same time to be better prepare when meeting the site owner the first time.
Available labs are ……. (to be completed)

2. Abbreviations

Site-OP	Site (mine or lab) operator and/or owner
TD	Test and Demo
Project	The test and demo project

3. Questionnaire

For projects that wants to test or demonstrate in production or test mines its important to notice that the mine owner or operator has a set of questions that must be answered and a set of criteria that must be fulfilled before a project can be allowed a test or demo. By being able to answer the following questions the project will be very well prepare to approach the mine owner and operator.

1. **Project goal**

   1.1 Give a very short description of the project that can be used by the Site-Op internally. E. g. Project consortium, what to TD, what type of results that are expected etc

   1.2 Describe what the Site-OP will gain from allowing project to TD. E. g. answering the Site-OPs question “What’s in it for us?”.

   Having this type of information makes it much easier for the Site-OP to establish necessary internal support for the project.

2. Project administrative

2.1 What is expected from the Site-OP

- Is co-financing expected in terms of cash or in-kind?
- Is some sort of reporting, from the Site-OP, expected
- What languages can be used for communication been people in the Project and Site-OP
- Is a NDA (Non-disclosure agreement) or any other type of agreement necessary to be signed by the Site-OP.?

3. Project details

3.1 Marketing of the project

- Is there plans to take pictures or make films etc for project marketing?
- Is it expected that people from the Site-OP will participate in marketing or marketing events.
- Is the intention that partners in the project will use the TD as reference examples in marketing?

  Note *that there are restrictions for the above, and that any type of project marketing must be approved by the Site-OP*

3.2 What type of TD site are the project searching for (of the four available TD sites)?

3.3 Will the project have people in TD that need to enter the mine itself or can the TD be done with project people just staying in e. g. control rooms or offices?

3.4 Is the project willing to take the cost for courses that will certify project people to go into the mine to do TD?

4. Project implementation

4.1 Project Equipment

- Will the project bring its own machines, vehicles or similar equipment, into the site, for TD
  and, if so, is the project will to take the cost for certifying those.
- Will there be sensors or similar equipment mounted on Site-OP equipment
- Is it necessary that the Site-OP is equipped with " things" from specific suppliers like e. g. Atlas Copco, Sandvik, Volvo, Scania, ABB, Siemens etc
- Is it necessary that the Site-OP is equipped with control, production, sensor or similar systems from specific suppliers?

4.2 Type of expected project support

- Is it necessary that Site-OP people are available during all TD
- If Site-OP people are expected to be available. Is that just for guidance and security or do the Site-OP people need to have an application knowledge so that they can be involved in the TD.
- What type of people (competence) is needed to be contacted at the Site-OP?
- Could it be sufficient if the Site-OP assign a third party for project support and is the project willing to pay for that support, if requested?

4.3 Project time schedule etc

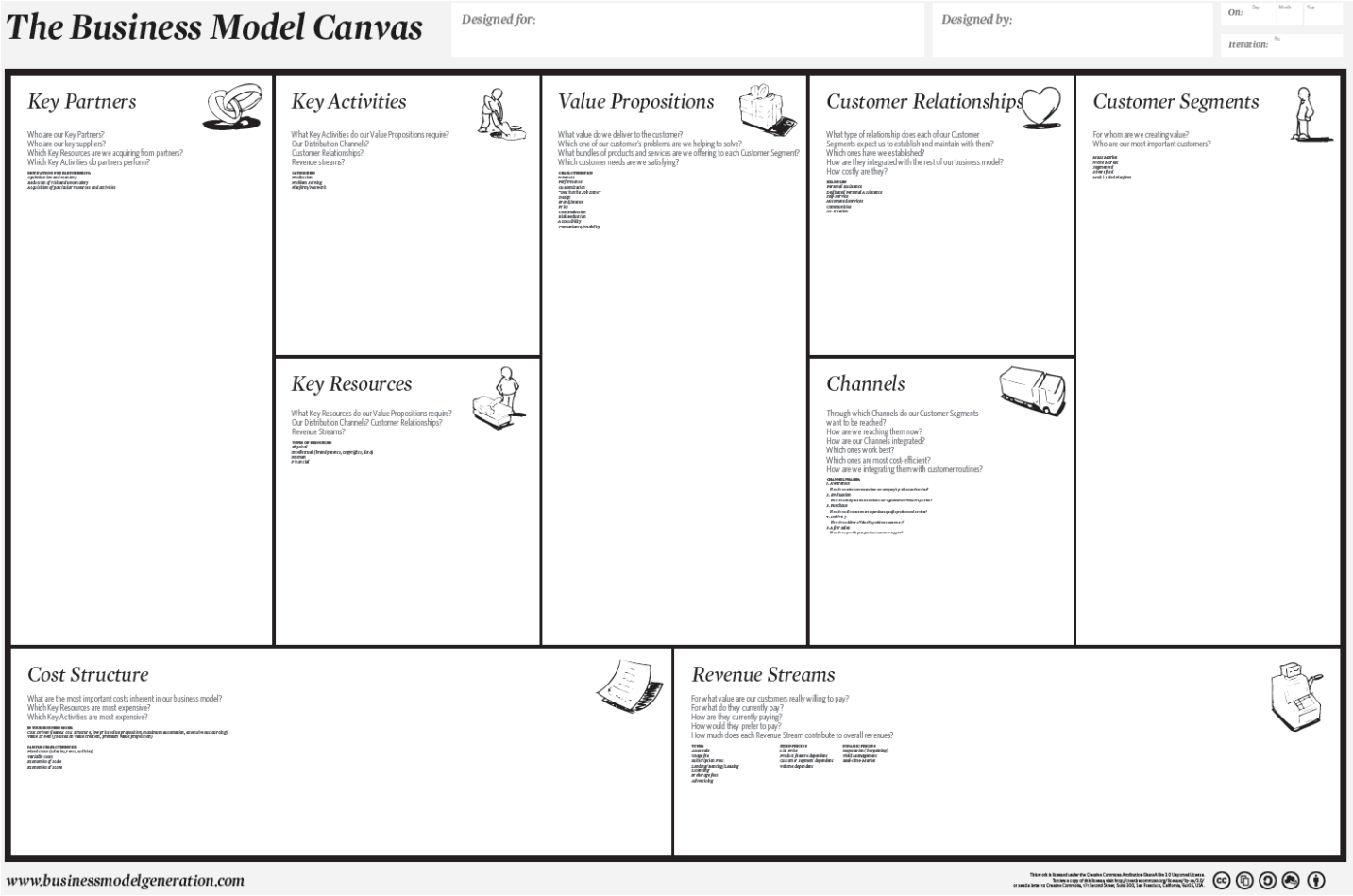
- Provide a draft for the TD time schedule at the site. E. g. how many times will TD be done, how long will each TD take etc.

4.4 IT and automation infrastructure

- Does the project need to have access to the Site-OPs infrastructure? E.g. for internet access, for wireless communication, for access to Site-OPs systems or data etc.
- Does the project need to have access to or use the Site-OPs IT or automation systems
- Does the project need to have remote access to the Site-OPs infrastructure or systems

Please provide *answers to this questionnaire, grouped according to headline numbers above.*

A3 Business Model Canvas



A 4 Summary WP2.4 Business models presentation

BSUIN WP2.4
REPORT

Current State of Business, Innovation and Co-creation
Summary

Helena Ahola, Päivi Aro & Taina Vuorela
OUAS

June 2018 to be presented in Äspö

Underground Labs

1. Callio Lab, Pyhäsalmi mine, Finland 21.2.2108
2. Ruskeala, Russia 7.3.2018
3. Khlopin Institute Underground Laboratory, Russia 17.5.2018
4. Conceptual Lab development co-ordinated by KGHM Cuprum R&D centre, Poland 2.5.2018
5. Reiche Zeche, TU Freiberg Research and Education mine, Germany 6.3.2018
6. Äspö Hard Rock Laboratory, Oskarshamn, Sweden 13.4.2018

2

WP2.4 / Current Business Model

- **Description of activity**: Facilitating service design / exploration phase workshops to describe and analyze the current business models of participating ULs by using service design. This activity will lead to service design / creation phase in WP3, Activity 2.
- **Outputs:** Business Model Canvases and Value Proposition Canvases of ULs, Workshops, understanding of different industrial contexts of the ULs in the network, shared understanding of existing business models
- **Timeline:** period 1-2
- **Responsibilities:** Representatives of each UL will take part in workshops, provide relevant information for context mapping (via observation, interviews) etc. prior to the workshops and invite relevant stakeholders to the workshops.

1

Co-creation

- Businesses need to become more innovative and respond more effectively to customers' needs and preferences
  - > co-creation
- The importance of a service-centred mindset, customer focus and collaboration between companies and their customers and other stakeholders
- Customers should be seen as active creators of value rather th an as passive recipients of goods and services
- Managers lack methods and tools which help them to understand and integrate co-creation activitiess into their business practises

4

Co-creation

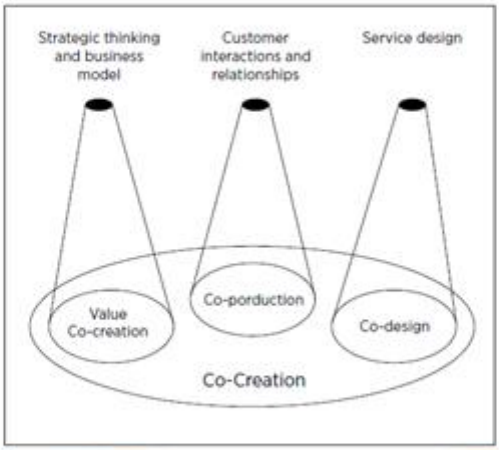
An umbrella concept that covers value co-creation, co-production, co-design, and co-innovation

Seen through three different lenses in service business:

1. A value co-creation view embedded in strategic thinking and business models
2. A co-production view embedded in customer relationships and interactions
3. A co-design and co-innovation view embedded in service design

5

Co-creation lenses



6

What Co-creation means?

Value co-creation in strategic thinking and business models:

- A service company needs to understand the value creation processes of itself, its clients and their customers.

Co-production in customer relationships and interactions:

- Customers are seen as 'active players' in roles as 'Resource' and 'as Co-producer' through diverse channels and platforms characterized by physical elements, processes and people.

Co-design and co-innovation in service design:

- Customers are involved 'as Informants' and 'as Co-designers'. By interacting and spending time with customers, profound customer insights may emerge.

7

Business Model

- Business model describes the logic of how a company intends to make money
- Business model describes the rationale of how a company/an organisation creates, delivers and captures value
- BMC is a useful tool for describing, analysing and designing business models
- Its key benefits – bringing clarity to a company's core aims whilst identifying its strengths, weakness and priorities

8

http://www.businessmodelgeneration.com/canvas/bmc

9

Current Business Models of the ULs

- CALLIO https://canvanizer.com/canvas/ryheruOzNzhLs
- CUPRUM https://canvanizer.com/canvas/rrvzI84LYLFrO
- KHLOPIN https://canvanizer.com/canvas/ruM9PPsSEoIw3
- REICHE ZECHE https://canvanizer.com/canvas/rtzfJcmp6HCUv
- RUSKEALA https://canvanizer.com/canvas/r67K4PaZPJavI
- SKB https://canvanizer.com/canvas/rTIAONMBsV9ju

10

What is a value proposition?

- It encapsulates a strategic management decision of what a company believes its customers value the most and what the company is able to deliver that gives it a competitive advantage

- It forces an organization to clearly articulate the basis of valued benefits from the customer perspective

- A good value proposition is concise and easy to understand

- It answers the question: If I am your ideal customer, why should I buy from you instead of any of your competitors?

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Comments on the Current Business Models of the ULs

- Paying customer segments are few in number
- Personal relationships, conferences, publications are important
- The most important customer segments are universities and research institutes
- Financial resources are generally scarce
- Human & intellectual resources are strong
- Business functions are not very often mentioned as activities, e.g. marketing, communication
- Partners are known well
- Revenue streams from paying customers are not substantial
- Fixed costs are significant

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Comments on Value Propositions

A value proposition consists of physical/technical enablers that create the conditions for the service experience.

- Uniqueness in each UL, e.g. specific know-how and expertise, infrastructure
- From the technical enablers to the services and service offering for the BSUIN network
- The current value propositions of each UL can be found in the business model canvas

13

'Best practices' from different ULs

- Important long-term data set / documentation for R&D
- Long-term relationships with certain customer segments
- Openness towards different stakeholders incl. the general public
- International co-operation, the ULs operate internationally
- Close contacts with research institutes and universities
- Tourism as a business
- Educational export as a business
- Strategic thinking & plans
- Active marketing of ULs' resources
- Role of an intermediator for services

14

Comments on Self-Assements

- The foci were:
  1. Strategic thinking and business model
  2. Customer interactions and relationship
  3. Service design

- The responses were given on a scale 1 – 3
- Qualitative tool
- Self-assessment is challenging
- Number of responses varied greatly (2-6)
- Each UL has received a report of their results based on self-assessments and interview
- Self-assessment is a part of the reports in addition to the input gained in the workshop and the interview

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Challenges

- The vision for the future; strategy
- Attracting new paying customer segments
- Finding new business opportunities and services
- The cost structure is heavy
- Organisational system / structure is complicated
- Customer understanding; understand the business of the customer
- Commercial customer relationships could be more actively strengthened
- Customers should be asked for feedback to improve ULs' operations

16

Questions from the OUAS team

- Benchmarking → what has been done with similar ULs globally: what are they engaged in?
- What is / could be the competitive advantage of the BSUIN network?
- How can the expertise of the whole BSUIN network be used when creating new business, e.g. BSI, TTU?

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Next steps (1)

Understanding the status quo of the UL?	Where does the UL want to go?	How does the UL get there?
• WP2 and especially WP2.4 • Period 1-2	• To be discussed with the UL • WP3.2 • Period 3-4	• WP3.2 (period 3-4) • WP3.5 (period 4-5)

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Next steps (2)

- Autumn 2018 / Spring 2019 --> Creation workshops with the principles of service design
- Co-creation in focus
- Representatives of each UL will take part in workshops and provide relevant information prior to the workshops and **invite potential customers and other relevant stakeholders to the workshops,** e.g. associated organizations
- The objectives and focus of the workshop will be decided jointly by the representatives of the UL and the facilitators

19

Next steps for the ULs to think about (3)

- Focus / objective / problem of WP3.2

- Minimum: to create a new service or improve an existing service
- What is the customer segment?
- The relevant participants (stakeholders) of the workshop

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Preliminary schedule for WP3.2

Autumn 2018

- Callio
- Cuprum

Spring 2019

- Ruskeala
- Khlopin
- Reiche Zeche
- SKB

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