REPORT
WP 3 Group of activities 3.1
Business Analysis

Baltic Sea Underground Innovation Network (BSUIN)

Interreg Baltic Sea Region
EUROPEAN REGIONAL DEVELOPMENT FUND
EUROPEAN UNION
BSUIN

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REPORT

WP 3 Group of activities 3.1 Business Analysis

Editor(s):
Assoc. Prof. Taurimas Valys
Dr. Birutė Miškinienė
Assoc. Žilvinas Jančoras
Vytenis Mockus

Vilnius University
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CONTENT

Introduction

The main purpose of this Business Analysis Report is to disclose the overall market and identify the core market segments (i.e. stakeholders interested in innovation activities and locations for innovation activities). Using the findings from Baltic Sea Underground Innovation Network (further – BSUIN) Work Package 2 (further – W.P.2) about the current state of infrastructure and organizational societal framework to outside users, the business analysis activity focused on the identification of stakeholders with interest to use the sites of BSUIN underground laboratories[1].

1. Methodology and description of its implementation ratio

Our team together with most of BSUIN members had 5 data collection road-shows in Finland (twice), Germany, Sweden, Poland, and Karelia (Russian Federation). In addition to this, we had a very constructive benchmarking visit at *Hagerbach Test Gallery* in Switzerland where we could discover the best practice activities relevant to us which in most cases could be incorporated into BSUIN business strategy and (or) project some synergies with our Swiss associated partners in a long-term period. The main aim of the mentioned study visits was to explore all BSUIN underground facilities physically, meet overall stakeholders (both existing and future) and discuss the potential with other colleagues from interdisciplinary areas. This allowed us to get a deeper knowledge about business feasibility and all possible scenarios of BSUIN existing and conceptional underground laboratories in particular locations. Typically, after seeing the UL infrastructure and meeting their representatives our workshop sessions began with an

[1] *How should the UL be market as a place for innovation and who is the target for this branding? The discussion was led among researchers, entrepreneurs, investors, branding stands for creating a unique approach.*

explanation of the situation. Thus, the main aim of this stage was to perceive the situation formed as well as possible. In order to emphasize this process, the *O generator* (1) was applied – in most of the cases the perception stage consisted of the following parts:

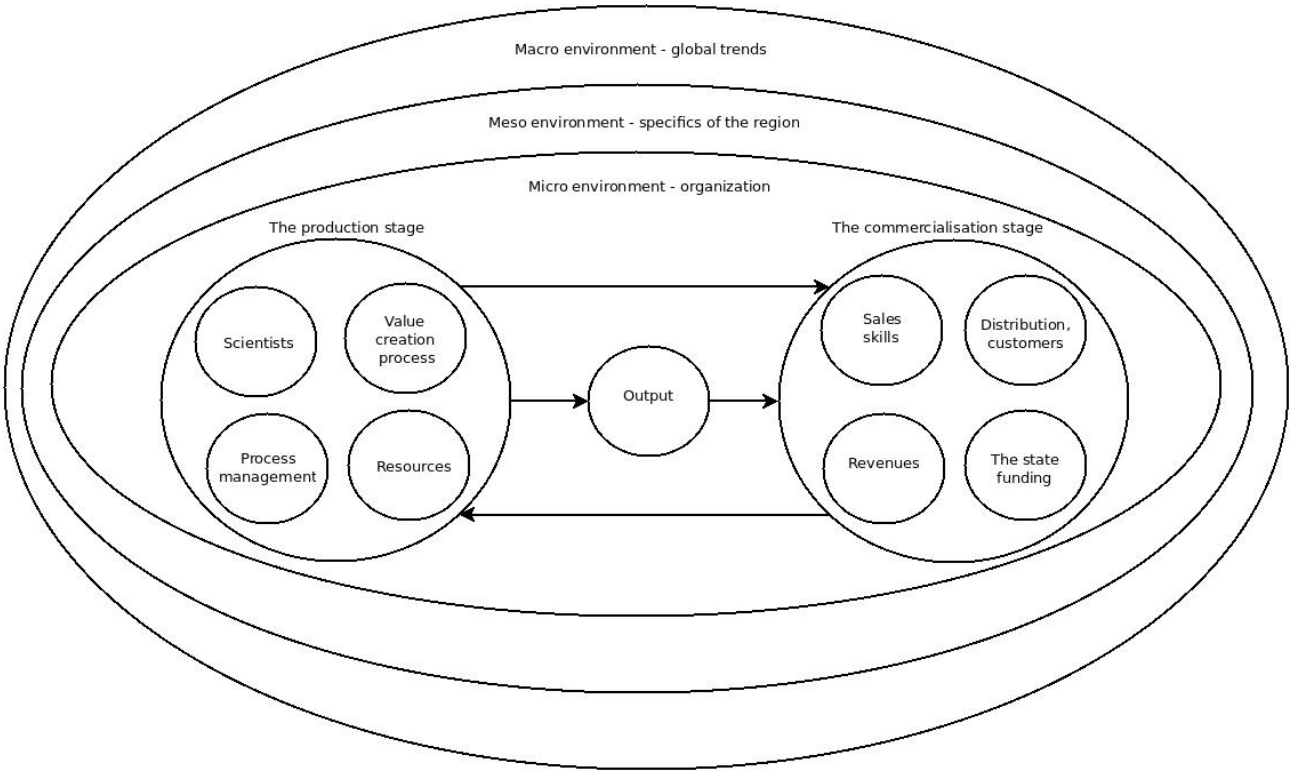
- *identifying problems,*
- *establishing positive aspects,*
- *preparing the priority list of the problems.*

It must be noted, that at the ideas generating stage attempts were made to find as many alternatives as possible to solving the problem identified and to find the "golden" idea, which would suit the specific situation best. The idea-generating stages consist of the following parts:

- *generation of ideas,*
- *establishment of the structure of the ideas and integration,*
- *evaluation and selection of ideas.*

Having found the ideas, a very important stage in seeking to implement it was operational planning. This was a traditional data collection, management, and analysis process (as it is shown in a Chart 1 below). Unfortunately, due to the fact that some of the BSUIN underground laboratories (further – ULs) were either only conceptional, either in quite immature development level, too little attention could be paid to this approach, especially in the creative process management. However, after the analysis was completed we got an optimistic outlook and see a big potential of BSUIN in business terms.

Chart 1. Data collection process and BSUIN Business Analysis logics.



Source: Jancoras Z. Strazdas et al., *MACRO, MESO AND MICRO FACTORS FOR CREATIVE INDUSTRY DEVELOPMENT: CONTINUOUS IMPROVEMENTS AND SYSTEM INNOVATIONS* https://www.researchgate.net/publication/281098344_MACRO_MESO_AND_MICRO_FACTORS_FOR_CREATIVE_INDUSTRY_DEVELOPMENT_CONTINUOUS_IMPROVEMENTS_AND_SYSTEM_INNOVATIONS

1.1 Autoethnography

During this process, after we got back from our data collection road-shows with our team members, before overall business we also used a method of autoethnography. It is a form of qualitative research in which an author uses self-reflection and writing to explore anecdotal and personal experiences and connect this autobiographical story to wider cultural, political, and social meanings and understandings. Autoethnography is a self-reflective form of writing used across various disciplines. According to *Maréchal* (2010), "autoethnography is a form or method of research that involves self-observation and reflexive investigation in the context of ethnographic fieldwork and writing" (p. 43). A well-known autoethnographer, *Carolyn Ellis* (2004) defines it as "research, writing, story, and method that connect the

autobiographical and personal to the cultural, social, and political" (p. xix). However, it is not easy to reach a consensus on the term's definition. For instance, in the 1970s, autoethnography was more narrowly defined as "insider ethnography", referring to studies of the (culture of) a group of which the researcher is a member (*Hayano, 1979*). Nowadays, however, as Ellingson and Ellis (2008) point out, "the meanings and applications of autoethnography have evolved in a manner that makes precise definition difficult" (p. 449).

According to Adams, Jones, and Ellis in *Autoethnography: Understanding Qualitative Research*, "Autoethnography is a research method that: Uses a researcher's personal experience to describe and critique beliefs, practices, and experiences. Acknowledges and values a researcher's relationships with others. Shows *people in the process of figuring out what to do, how to live, and the meaning of their struggles*" (Adams, 2015). "Social life is messy, uncertain, and emotional. If our desire to research social life, then we must embrace a research method that, to the best of its/our ability, acknowledges and accommodates mess and chaos, uncertainty and emotion" (Adams, 2015).

1.2 Expert interviews

It must be noted that expert interviews used to have significant advantages over other methods of data collection. For instance, due to the fact that respondents are highly qualified in the analyzed question, it eliminates the need to use additional screening and clarifying questions aimed at revealing true, but hidden from the interviewer respondent views – this type of survey is uniquely aimed at obtaining reliable data because respondents` competence is very high (*Dorussen, Lenz, Blavoukos, 2005*). Therefore, expert interviews were very important during this business analysis – even though the

quantitative data collection process became more prevalent than regular qualitative methods.

1.3 S.W.O.T. and additional analysis based on questionnaires

In parallel, we structured particular questionnaires (provided as Annexes) for a survey in which the respondents simply ticked the answers that applied to them; the data was later statistically evaluated, compared, and analyzed. It was finalized in spider diagrams[2] which illustrated the existing related trends of the overall business environment in particular locations of BSUIN.

Above all, during all data-collection roadshows in all 5 countries of BSUIN ULs general Business Analysis also consisted of detailed SWOT (*strengths, weaknesses, opportunities and threats*) analysis and the answers (position) were got from all possible stakeholders during workshops and further communication channels.[3] The combination of all the mentioned above allowed our team to get the most accurate and efficient "big picture" of the current situation and potential of business in general in all BSUIN. Ultimately, the data obtained by using all the methods mentioned above were mutually processed and analyzed, then it went through systematization and interpretation, finally, ended with brief conclusions by each UL case.

It must be noted that our SWOT analysis are mainly based on the opinions / positions of our respondents (as representatives of various target groups). Therefore, there was no

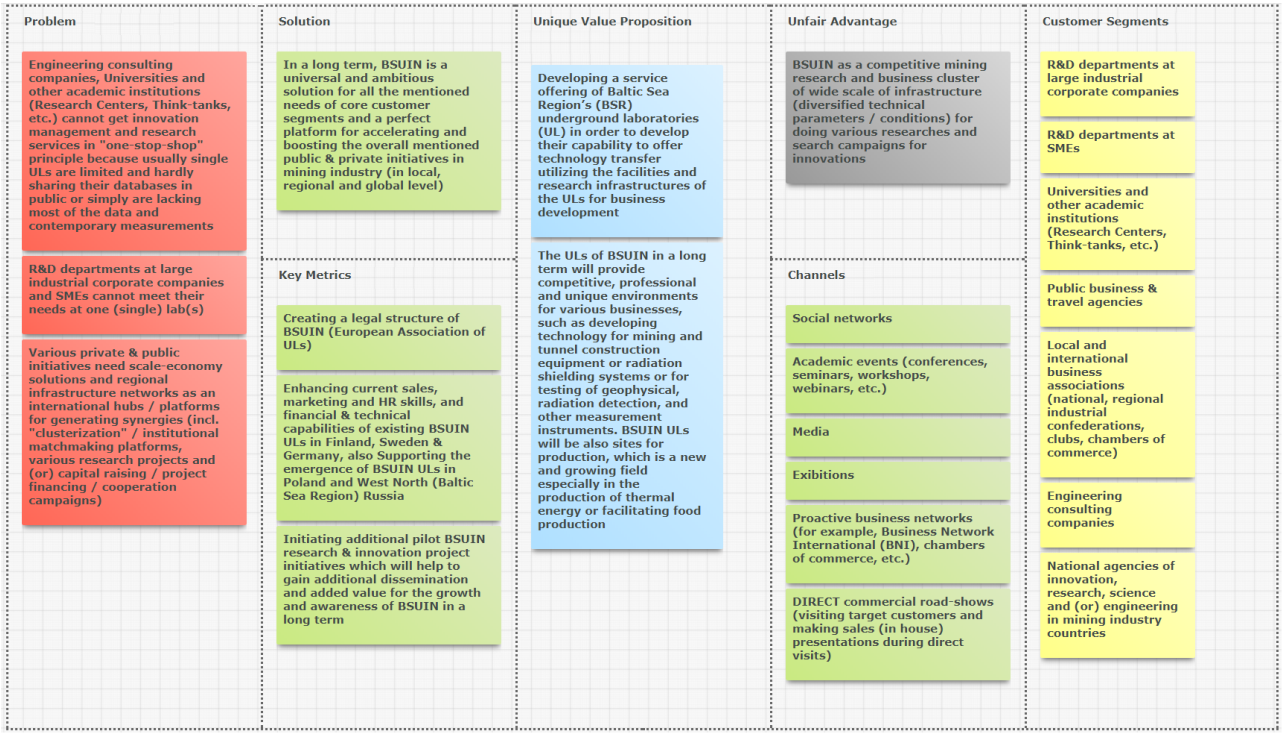
[2] *The spider diagrams were used in order to compare five or more items under various functions of typical metrics. Therefore, each item might covered a fixed area based on its data.*
[3] *In fact, the order of this Final Report of Business Analysis is made in the same order as all data collection road-shows and related stages were implemented.*

need to apply any censorship in the process mentioned above. This method preliminary indicates the intensity of answers and authentically generates opinion trends. Above all, in order not to lose the volume of the answers and to emphasize the SWOT analysis trends and final conclusions special "pie" charts were made in each of the UL case.

1.4 Lean Canvas

It must be noted that this Report will precisely follow and present the approach shown on this specially adopted *Lean Canvas of BSUIN* bellow based on the outcomes of the overall Business Analysis and focused on its core goals and elements (including identified core market segments, value proposition, channels and other elements which are considered as guarantees of BSUIN efficiency, uniqueness, competitiveness and at the same time could be identified as brief business guidelines for mutual success in the nearest future.

BSUIN Lean Canvas.



Source: *prepared and managed by Vilnius University team.*

2. Reiche Zeche, Germany[4]

Picture 1. Reiche Zeche quarters.

MAJOR ROCK TYPE(S)

Freiberg deposit is a lead-zinc deposit. In carboniferous to Permian and late Jurassic to tertiary periods ore veins have been created within the already existing gneiss in connection with the Variscan and alpine orogeny. The main minerals to be found are Galena, Sphalerite, Pyrite, Chalcopyrite, Arsenopyrite and Quartz.

THE ORIGINAL PURPOSE, CURRENT USE AND FUTURE PLANS

The mine "Himmelfahrt Fundgrube" was founded as a consortium of multiple individual shafts in 1839 to enhance the production of silver in Freiberg. It was first closed in 1913 and handed over to Bergakademie Freiberg in 1919 for teaching purposes. In 1937 the mine was reactivated and once again in operation until 1969. Finally, in 1976 the shafts "Reiche Zeche" and "Alte Elisabeth" were handed over back to the University for research and teaching purposes. Today multiple research institutions and partners from industry use the mine as a fundament for the development of new technology, production methods, new materials or to gain reference materials for their

[4] *Basic information was used from official website www.bsuin.eu, which was officially provided by UL Partners.*

databases. In addition, multiple Universities make use of the mine in order to train their students practically in mining and surveying operations. It is intended to develop the mine to a European platform for enhancing mining techniques and education. For this, it is planned to create new access (ramp) and to develop new fields, rooms and drifts.

ACCESSIBILITY

Freiberg can be reached from:

- *Dresden Airport within 45 minutes by car (50 km) or 1 hour by train via Dresden Central Station*
- *Prague Airport (Czech Republic) within 2 hours by car (140 km) or 4 hours by train via Dresden Central Station*

OVERALL DATA AVAILABILITY

The data of research activities are collected, processed and stored by the performing partners individually. It is possible to provide contact information to these partners. Some general data on the mine are available as textbook or paper.

SPECIALISED KNOWLEDGE, SERVICES

Specialized knowledge, laboratories and workshops are available in all mining and raw material related fields at the individual departments of the university. The mine management is capable of establishing underground laboratories, workshops and office spaces for long-term projects.

Picture 2. Data collection process during Reiche Zeche road-show.

2.1. S.W.O.T. table 1.

Strengths	Weaknesses	Threats	Opportunities
Open for non-mining solutions	Accessibility (too little information)	Safety issues (a lot of people - researchers and others – at the mine)	Special questionnaire for visitors "what you want to see next time after you visit the site?"
Open for education	Too little space for experiments, space is expensive	Long term storage of information: offering no forms, partly no complete overview, risk of losing information	Open door day events +seminars: intro about possibilities
well organized	Accessibility limits opportunities and raises cost	Stop of the State (Saxonian) support for the mine	Virtual reality tour (360-degree video)

	level with certain investments and maintenance		
good infrastructure	Recruitment / expanding - public entity has some restrictions on recruiting processes. How to increase the capacity?	not enough number of students to keep mining department	Value propositions (and services) could be described more clearly
accessible	Access to the mine is limited (in time per day; size of materials); bottleneck elevator	Operation (time) of mine	Concert hall, other facilities / activities (more music, concerts); (maybe nor in Reiche Seche, but might be relevant in other ULs
Well organized, great staff	Limited geology	During the researches mine can be poisoning the water	Global facilities for electromagnetic free environmental testing
A lot of dry places	Restrictions by laws organizing university: inflexibility for new employees, long-term contracts, etc.	Evacuation for big group of people	BSUIN network
Constant temperature shelter in case of apocalyptic scenarios	Problem safety access to particular spots in the mine	Negative Economic cycles / turbulences	plants growing and (or) testing
Funding is OK	problem with fast (operative) communication	Legislation obstacles for new activities underground (existing legislation) ---> we need to educate politicians	Sports tourism
Public funding and commitment (solve maintenance cost-problem)	overview of possibilities and existing projects (as public webpage)	Stagnation: not cost reducing innovations or development	Virtual excursions (360-degree panoramas)
perfect sun protection	Place lab for preliminary tests	lack of thinking "out of the box"	Tourism: historical place, Near Dresden and motorway
Great utilization of geothermal energy --> advertise, develop further	Due to state ownership some political risks (bureaucracy, etc.)	Environmental impact	education center for night activities
Easy contact proximity	some reputation issues - unknowing of mine, incl. UL - dark workplace, cold, expensive for testing (solution: promote "best practice studies")	Potential safety issues while some accidents due to an old infrastructure and tools	"escape room" underground

Infrastructure	complex approach for communication efficiency due to German law restrictions	Challenge accessibility	interactive website with services and existing experiments
Location in Central Europe	safety access of users to underground facilities after "working" hours	Safety accidents	Joint projects in cultural change (beside the scientific projects)
Maturity of infrastructure	Access with machinery to underground very limited (now labor is intensive)		Create a gallery of tools and equipment used in the past (retrospectively) - perhaps in AR / VR
Well set-up legal and authority approval approach	Understaffed --> Robotics		Entertainment events in underground environment
access to geology hard-rock lab and strong connection to TUBAF	PPE		Wide range of research opportunities
Long history and area traditions	Small mine, hard to take bigger equipment --> smaller equipment remote control		Development of historical knowledge about past of the mine
reliability	Mine resources / environment		VR mine learning center
Tailor-made approach	Liability issues ---> breakdown & downtime compensation of partners		Mining study area for all European mining schools--> fieldtrips, workshops at UL or related
Long history and area traditions in mining education	Accessibility		Global mining center
Cooperation with public authorities, mine maintenance	service descriptions + costs (should be clearer for potential new users)		More intensive interacting with university
funding by regional institutions	Organization is staff (limits)		Tunnel-view
well-trained staff	Cleanness (in lifts, tunnels, etc.)		Global scale mining school
Flexibility	Tunnel view		Research attractiveness for interdisciplinary investigators
Flexibility	Clarity of value proposition for services		development of clear service concepts
Strong existing Business network	Poor visibility online		More intensive tourism development

Best practices for other underground labs	limited access of working hours		communication and navigation technology development & testing
long history and traditions in mining (global brand)	selective access to the UL (not possible to test with particular mining machinery)		partly new technology can be tested like underground pump storage systems
mining experience	difficulty in exit / entrance (small elevators)		auxiliary services are comfortable to organize medium-sized town
well-known underground	mostly research oriented instead of company-oriented (approach)		Tourism development in more intensive way
diverse background knowledge	communication plan		Tourism development in more intensive way
Multitude of research options from geophysics to bioleaching and tourism; easy to expand further, operational level is enough to support itself	protection safety gear for guests: hand gloves missing, rubber boots (it must be noted that perception point for guests / customers is very important)		
interdisciplinary research approach possible	infrastructure limitation		
tight connection with academic background	Insufficient number of staff for larger groups of visitors		
UL is connected with university, researchers, students	old mining equipment, slow		
interdisciplinary research approach possible	extremely limited infrastructure		
strong academic support	Limited access to mine (time per day, size of elevator)		
open for educators	Accessibility		
best practice in mining education			
Freiberg - young city, many students			
University lab			
Connection with the University and its academic environment			

good reputation due to long history as an active mine and as a training facility for many decades / centuries			
location (can be reached from Oulu in 7 hours)			
Central location			
Professional and flexible staff			
Customer oriented staff			
University research			

Source: *prepared and managed by Vilnius University team*

2.2. Chart 2. Spider diagram outcomes

Source: *prepared and managed by Vilnius University team*

In order to sum up, as SWOT analysis and this spider diagram above (*prepared based on questionnaires (Annex), additional expert interviews, and discussions with potential customers above*) shows, the strongest parts of these UL facilities are human resources and infrastructure. Also, business analysis shows that management and processes are being

handled quite well. The week points that need to be improved are the following: marketing, dissemination (publicity), overall sales. Without the mentioned improvements it is hard to create competitive innovation nor attracting the best strategic partners and developing both commercial and research ideas.

2.3. Business Analysis Conclusions

Chart 3. Analysis Trends of Strengths: *Reiche Zeche* case

Source: *prepared and managed by Vilnius University team*

Chart 4. Analysis Trends of Weaknesses: *Reiche Zeche* case

Source: *prepared and managed by Vilnius University team*

Chart 5. Analysis Trends of Threats: *Reiche Zeche* case

Source: *prepared and managed by Vilnius University team*

Chart 6. Analysis Trends of Opportunities: *Reiche Zeche* case

Source: *prepared and managed by Vilnius University team*

In business synergy terms, leadership among other BSUIN partners is possible in the tourism sector. Since Reiche Zeche infrastructure with surrounding areas is one of the oldest places not only in Germany but also in Europe where mining as a sector started to

emerge and develop globally, it is getting quite many visitors every year. Of course, it is always possible to expand and try to attract more visitors. However, the existing know-how and experience allow the Reiche Zeche to lead in this tourism area in BSUIN put together with other members and prioritize all possible innovations and researches in this particular direction. This specialization would give uniqueness for the lab and also would help to build a separate direction in BSUIN as a niche of the future cluster in a long-term period.

After several meetings and discussions with various potential customers – core stakeholders with interest to use the sites of BSUIN underground laboratories (full-scale size corporates (members of local regional national and international chambers of commerce (such as American Business Network International (BNI), various national confederations of industrialists in Europe, Asia, Americas, and the Middle East, et al) – and academic research partners we found that this approach, in particular, would allow to attract them and generate synergies with small and medium-sized enterprises (SME), large corporates with strong R&D departments. Also, after conversations with various local and regional travel and business development agencies, it was found out that private businesses are willing to initiate and develop private and public partnerships in the mining tourism sector. Such private initiatives would allow to ensure the additional financing flow and generate necessary best practice pilot projects which will be possible to be extrapolated among both BSUIN and new (future) members of BSUIN as a cluster or at least as its competitive niche (specialized) direction.

Finally, it is necessary to boost the strengths of the Reiche Zeche. First of all, it is a must to expand the scope of research, specialize in narrow areas, and achieve the status of an

excellence center. Secondly, it should expand the scope of cooperating study programs by including not only mining and geology but also related to engineering and history. Thirdly, it is very important and needed to expand student exchanges, involve BSUIN partners, and other student exchange networks. Fourthly, as a pilot initiative (solution), regarding the mentioned niche tourism direction, could be creating an educational cluster for families. This would connect the Mine and UL with regional museums, culinary heritage restaurants, tour operators, tourist centers, and hotels.

3. ÄSPÖ HARD ROCK LABORATORY, SWEDEN[5]

Picture 3. Äspö quarters.

MAJOR ROCK TYPE(S)

The two dominant crystalline rock types on Äspö island are Äspö diorite (quartz monzodiorite to granodiorite, porphyritic) and Ävrö granodiorite (granite to quartz monzodiorite, generally porphyritic). The age of these quartz monzodiorites, granodiorites, granites, are in the order of 1.8 G years. Important subordinate rock types are dykes, veins, patches and minor bodies of fine-grained granite, pegmatite and composite intrusions.

[5] *Basic information was used from official website www.bsuin.eu, which was officially provided by UL Partners.*

ORIGINAL PURPOSE, CURRENT USE AND FUTURE PLANS

The Äspö HRL was constructed for the test, design and construction of a deep geological repository for the final disposal of the Swedish spent nuclear fuel and is in operation since 1995. The current use is for different methodological and technical development for final disposal of spent nuclear fuel in combination with the new use for projects such as environmental, geotechnics, geo-energy, material science and various technical development projects. The aim is to turn the facility over to future research and development stakeholders.

ACCESSIBILITY

The island Äspö can be reached by car from Stockholm within 4 hours. The distance between Stockholm and Äspö is 340 km. The nearest regional airport is located in Kalmar and can be reached from Stockholm Arlanda airport within 1 hour. The travel time by car between Kalmar Airport and Äspö is 75 minutes (100 km). Kalmar can also be reached by train from Copenhagen airport in Denmark within 4 hours.

OVERALL DATA AVAILABILITY

All data from SKB's investigations and research activities are stored in SKB's Site Characterization Database (SICADA). The data in the database are available for researchers using Äspö HRL for ongoing or planned research activities at the site. The database contains more than 400 million observations.

SPECIALISED KNOWLEDGE, SERVICES

Specialized knowledge in geology, hydrogeology, geochemistry, groundwater chemistry, geophysics, rock mechanics, rock engineering, clay materials and especially swelling clays etc. Scientific and technical experts available at the site or in different networks. Organization for guiding, planning and starting external projects including experimental services ranging from drilling and measurements to construction of prototypes.

Picture 4. Data collection process during *Äspö* road-show.

3.1. S.W.O.T. table 2.

Strengths	Weaknesses	Threats	Opportunities
Infrastructure in place (boreholes, tunnels, labs, custom test equipment, for example, bentonite research	International (non)visibility; countryside Sweden, not on the level it could be	No payer for maintenance costs in the future (after 2023)	attract new customers
People with knowledge, data, etc.	Initially it seems that most of the focus is mainly based on raw material – bentonite *(however, of course, there are many other areas of development – it is not the only direction)*	lack of creative alternative scenario	Central in the Baltic Sea region (big potential to develop transport and accommodation business)
Bedrock well investigated / fairly typical conditions of Sweden	Why no perspective after research for nuclear waste storage	Lack of alternative financing resources	Virtual and physical location for knowledge and tech-transfer
Well known geology and geophysics	focused mainly in nuclear waste storage researches	Financial funding	Knowledge transfer to other countries in the field of nuclear research

Facilities are over ground well developed for visitors and users	Location close to power station	Diversifying search of future overall solutions	Other use of the facilities
Openness	not enough attention for increasing the amounts of visitors	Lack of alternative financing resources	Remote area allows for more extreme tests (blasting, boring, etc.)
Multidisciplinary professional staff available	lack of diversity in different business segments	Lack of alternative financing resources	Focus must be more on summer schools and students (geo-university - globally); thinking of Colorado School of Mines in Gold; Better transportation
Good UL accessibility by ramp	focus mainly to specific research aspects of SKB nuclear waste storage	No payer for maintenance costs in the future (after 2023)	Children camp of science
Joint service of well-equipped UL - Lab+workshop facilities	Customer understanding (better)	No payer for maintenance costs in the future (after 2023)	Some area for test experiments for various age children
Deep knowledge - testing in nuclear research --> knowledge transfer to others; open-minded to every type of research in underground; cooperation with local community and research	Make customers active participants and players	lack of funding might lead to scaling down of facilities and loss of scientific valve	Field courses for University students
Location, developed underground infrastructure, good staff	Location might be too dar away to flatter new clients	Big revenue streams are needed in order to maintain the infrastructure in the future (tourism is not enough)	Field courses for University students
Cheap houses (if found)	to few services for visitors	Funding to keep the facility open	Tourism
Good infrastructure	opportunities to attract tourists are not yet fully developed in terms of marketing and additional services	Housing	Specialized summer schools
good relationship with municipality	public communication for traveling change[s] 3 times	Big costs	More diversified customers
Big experience in international cooperation	customer data communication and utilization	Lack of funding after 2023	Local products

Long history, many researches, lots of data	location - small town - not a typical "hub" with surrounding universities and larger companies	new customers need to be found - it is long term job	More tourists and UI customers
SKB and other companies	far away from major or urban areas in Sweden	Huge costs	Geo tourism education
Independent (free) from industry production stress factors	remote location	Termination of funding after 2023	Sports (paintball, et al.); augmented reality
Very well investigated area / volume = a lot of high-quality reference data	location of the facility	Increased diversity of projects /activities and financial contributors / sources - particular management skills are needed.	Tourist attraction
Good local round & logistics / infrastructure	ASP is far away from Capital city (Stockholm) - hard to reach from everywhere	Competence and service decrease in mid-term period	other services from waste management areas
Near to Oskarshamn	hard to get financing	Attract the right stakeholders to build consortium: for finding finance and reducing costs	new customers, diversification of activities
English speaking staff	hard to attract staff (incl experts, companies)	No suitable usage	Creating a research village
Outstanding infrastructure	big costs of live meetings	New business model is needed	Expertise knowledge - where it can be used?
Interest of international market players	not the best accessibility from abroad	new staff issues	Cultivation / research of vegetables or other species
Resources: infrastructure (high level), HR (competence)	disturbed ground conditions not suitable to study natural conditions	Nobody is interested in this place	future monitoring at wasted fuel
Well organized: responsibility, strong control (safety requirements)	No university close to the area	Politics	Beautiful surroundings - housing, related activities.
Solid funding until 2023 (incl. SKB and local community support)	High humidity is important for some equipment	Case of fire - total site destruction with current fire prevention approach	Museum, interactive workshops, groundwater contamination (tourism), underground camping
Long term research - know-how (over 30 years)	Too deep	Earthquake	New Business customer segment (services for the segment)

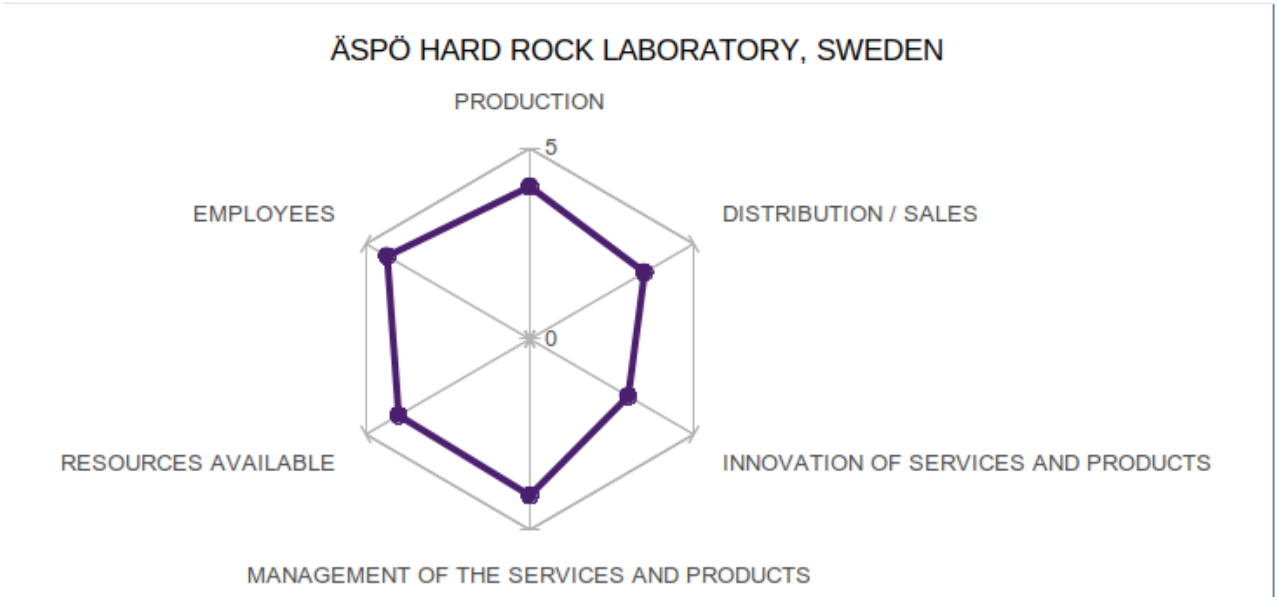
Unique, accessible environment for research & development	The database (SICADA) is very hard to use (=useless)	Neighborhood with NPP where could be an accident(s)	Attracting global scientists from other areas than nuclear fuels treatment
Long and well researched time test site (geo over ground, underground, etc.)	old technique		diversification of activities
Deep and long existing system	no overview		Expanding international cooperation with global scientists
High level safety system and organization	only one person can handle SICADA properly (Marie)		Wider diversity of customers
Nice surrounding (buildings, related infrastructure, etc.)	dependence from one shareholder		"Mining Disneyland"
means of transportation	significant operational costs for keeping UL open (dewatering)		Tourism exposure
size of underground drifts	running costs - 60 people as max underground		Potential in tourism in combination with R&D activities
established / available labs at surface	Missing local accommodation and close connection to Flist		Recreation - "atomic Disneyland"
Financial situation till 2023	Expensive		Public Private partnership(s) promotion
Strong owner	Expensive infrastructure - no financing after 2023		Internationalization
strong R&D background	Business model needed		Tourism promotion
open to external clients, tourists and science	Expensive to operate		R&D activities
30 years of experience in research	Highly developed infrastructure and site costs		Many different locations for research and tests
unique data	Housing / Lodging		research areas
available service organization	Place(s) to stay overnight at Sight		Income from R&D provision of interdisciplinary R&D services
Geoscientific data	Restaurant		Attract other research areas

High level quality data	Oskarshamn lacks opportunities for transportation		Development of Hospitality services: constructing new accommodation and restaurants; combined with heating / cooling solutions; with solar collectors; heat pumps, boreholes, ice-tree roads, tunnels, hunting infrastructure
fantastic area (beautiful)	Geographic location		experiments hub
Strong network	Geographic location / Infrastructure / needs wider research areas		possible synergies with nuclear power plant decommissioning
Special know-how	Location		attracting big industries
Facility-Infrastructure	Extreme temperature conditions is not possible		testing large scale mining equipment
Environment	Distance to main hubs		open days for big companies
Good service	Distance to young scientists		story telling approach - increases sales
Safety	Geographic location		external financing
Support by local authorities	Communication / marketing		National geosphere Laboratory concept --> Swedish research infrastructure roadmap
Local community is involved	Housing (not enough)		R&D and master courses
Great infrastructure	Location. Transportation		SMEs acceleration
The mine is open for researches	Accessibility for visitors / limited attractiveness to talents		improve accessibility to all data (new and modern database): - really crucial and fundamental; - a must
User-friendly approach	Lack of diversity in different business segments / fields of science		NW information park
transparency	International accessibility		safety storage for documents or other things (servers)
Good resources	Too little number of Master and PhD candidates among staff		

Data set / base			
very unique and wide data available			
Experience knowledge			
Deep knowledge			
Transparent bedrock			

Source: *prepared and managed by Vilnius University team*

3.2. Chart 7. Spider diagram outcomes



Source: *prepared and managed by Vilnius University team*

In order to sum up, as SWOT analysis and this spider diagram above (*prepared based on questionnaires (Annex), additional expert interviews and discussions with potential customer above*) shows, the strongest part of *Äspö UL* facilities is a very strong team, which is well equipped, great infrastructure and general management which helps to achieve good results of the activity. However, publicity, awareness, and overall sales could be more

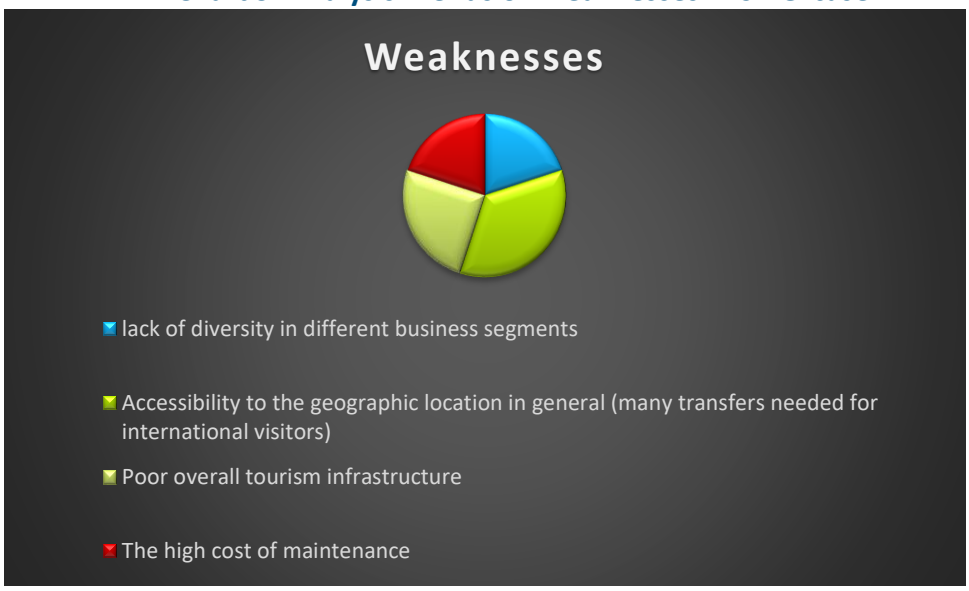
activated. In parallel, this skillful team should more intensively promote innovation through the use of its core competencies.

3.3. Business Analysis Conclusions

Chart 8. Analysis Trends of Strengths: *ÄSPÖ* case

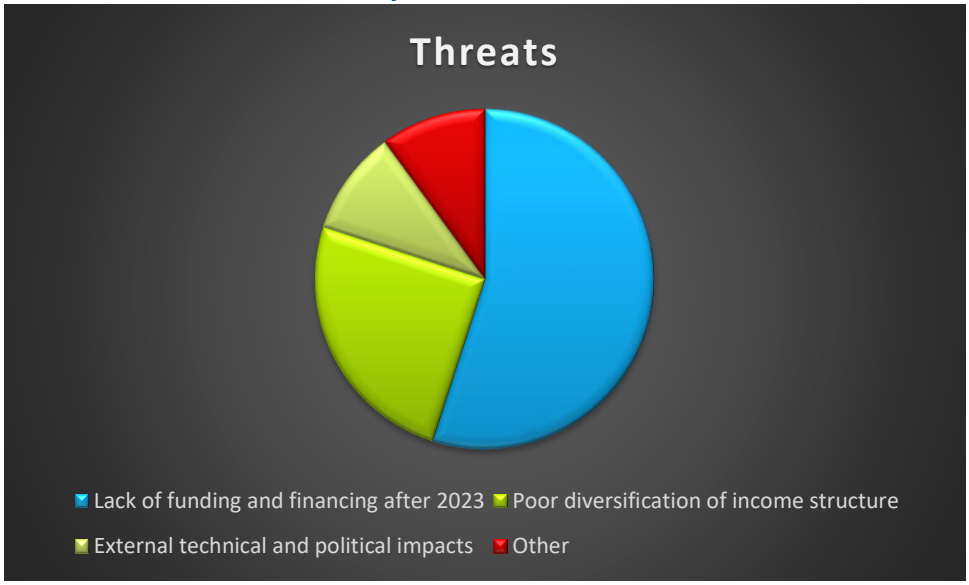
Source: *prepared and managed by Vilnius University team*

Chart 9. Analysis Trends of Weaknesses: *ÄSPÖ* case



Source: *prepared and managed by Vilnius University team*

Chart 10. Analysis Trends of Threats: *ÄSPÖ* case



Source: *prepared and managed by Vilnius University team*

Chart 11. Analysis Trends of Opportunities: *ÄSPÖ* case

Source: *prepared and managed by Vilnius University team*

Firstly, it must be noted that the research and tests at *Äspö* UL are not based only on bentonite. Massive efforts are taken to characterize and understand the geoscientific properties and processes in crystalline rock at site and in general. *Äspö* UL also develops and tests different kind of vehicles and equipment for rock excavation and handling of

nuclear waste. Thus, one of the main suggestions for *Äspö* UL is to consolidate the main strengths of the mentioned above by positioning itself as the core hub of nuclear waste inside of BSUIN. In this direction of cooperation, it should boost the knowledge of the final repository for used nuclear fuel by an ambition to become a global center of excellence in this area[6].

Secondly, it must be emphasized that *Äspö UL* could continue developing innovative laboratories, especially the ones which are related to the overall radiation area. Its track-record and know-how are competitive on a global level and this element could attract very different customers to BSUIN who / which would order additional services and potentially generate innovation and research projects for other BSUIN members. Such an extra scale economy effect is very important and useful for the entire BSUIN member because it generates additional synergies and becomes a core trigger for more niche researches which is strengthening the competitiveness of BSUIN on a global level[7].

Thirdly, the surrounding areas of *Äspö UL* are really impressive and beautiful. For this reason, it could join the mentioned touristic sub-network of BSUIN and get additional

[6] *According to representatives of Äspö HRL , SKB International (the subsidiary company) continues to market Äspö HRL as the most suitable UL in the world for NWM research and tests in a crystalline rock environment. The outcome of the marketing activities is not and will not be enough to balance the operating cost of the facility. It was experienced that the world-wide NWM field is too narrow to "fill up" Äspö HRL with research and test activities. It is a must to attract other research fields as well.*

[7] *It must be noted that Äspö HRL is already a globally renowned UL for NWM research and tests. Actually, SKB International are working hard on achieving new contracts with NWM organizations world-wide. It is a time-consuming process and just now even more demanding because of the pandemic situation. Some other countries prefer to bury their spent nuclear fuel in sedimentary geological formations in layers with petrified clay. In Sweden it does not have that type geological formations. KBS-3 method is developed to be a safe solution in crystalline rock. The safety is obtained by using a very corrosion resistant cannister material like copper. Disposal of radioactive waste in thick petrified clay layers requires only common construction material like steel. Hence, RWM research and test activities in crystalline rock environments is a very tiny customer segment.*

financial flow from extra international visitors and, potentially, new research project partners.

Finally, since the solid funding is guaranteed only until 2023; the pre-planning for decommission has started in parallel with efforts taken to find new customer segments. Hence, the situation is urgent. In order to get the more intensive and fruitful scale economy effect from all the mentioned above, Äspö UL could additionally activate training of radiation protection specialists by promoting interdisciplinary master and PhD students (*also postdoctoral scholars*) exchanges and developing interdisciplinary study programs. In a long-term perspective, new initiatives in the mentioned area, related pilot projects and researches will attract additional (alternative) grant financing and private financial initiatives (for example thought DBA studies and similar private business demand-based requests.

4. KGHM Cuprum R&D Centre, Poland[8]

First of all, it must be noted that *KGHM Cuprum R&D Center* is not managing UL so far, but after a data collection road-show with BSUIN partners, it was found out that its core corporate owners have all the necessary infrastructure, financial capabilities, and quite a big interest to install it in a mid-term period. This approach is based on the internal demand of related researches, indicated opportunities to gain additional income from external customers and, above, all believing in synergy potential within participation in BSUIN activities in the future. Thus, today this is just a conceptional UL, in comparison to what BSUIN has in Finland, Sweden, and Germany.

Picture 5. KGHM Cuprum quarters.

[8] *Basic information was used from official website www.bsuin.eu, which was officially provided by UL Partners.*

MAJOR ROCK TYPE(S)

A productive level located at the depth from 900 to 1200 m is overlain by thick, good quality dolomite layer, which is followed upwards by rigid anhydrite strata of around 150 m of thickness. Above them, salt rock and more than 300 m of Motley fine grain sandstone are deposited. Below the copper-bearing ore, a thin layer of quartzite sandstones precedes some 300 m thick layers of hard Rotliegendes sandstones. In the geophysical analyses, an average rock mass compressive strength is about 140 MPa for the strata above the copper ore deposit, 50 MPa for the deposit layer, and 30 MPa for the floor layer. The depth of the ore body, an ability to accumulate strain energy by both the upper layer of anhydrites and the lower sandstone layer as well as highly variable tectonic conditions constitute grounds for generating violent seismicity and rock bursts.

THE ORIGINAL PURPOSE, CURRENT USE, AND FUTURE PLANS

The KGHM mines were constructed mainly for the copper ore excavation, processing and smelting. They are constantly under development for almost 60 years. In selected areas of existing mine workings, pilot/trial panels used to be furnished for research and development purposes.

ACCESSIBILITY

The KGHM mines are located about 75 km NW from the capital of Lower Silesia – Wrocław with circa 650000 inhabitants, railway station, international airport, universities, and other high education and research institutions. The A4 motorway and the interregional road S3 guarantee easy access to the mines. The nearest regional airport is located in Lubin.

OVERALL DATA AVAILABILITY

All data from KGHM's investigations and research activities are stored in KGHM's archives located at the appropriate departments in the mines and the main offices in the Lubin headquarters. The databases generally are not available for researchers unless they are authorized.

SPECIALISED KNOWLEDGE, SERVICES

Specialized knowledge exists in geology, hydrogeology, geochemistry, groundwater chemistry, geophysics, rock mechanics, rock engineering, clay materials and especially swelling clays etc. Scientific and technical experts available at the site or in networks. Organization for guiding,

planning, and starting external projects including experimental services ranging from drilling, measurements to the construction of prototypes.

Picture 6. Data collection process during KGHM Cuprum road-show.

4.1. S.W.O.T. table 3.

Strengths	Weaknesses	Threats	Opportunities
CUPRUM KGHM and its resources available for the UL	productive mine/mine in production (action) - research is not a priority	"Public Acceptance" (accidents, etc.)	new research field(s) development opportunities
Mining experience (high level)	regulations due to active mining (more restricted)	Strong Environmental restrictions (incl. hiring aspects et al.)	new research field(s) development opportunities
Mining heritage topics, involvement in other different topics	CUPRUM mine might be focused only on copper and salt and its issues	The biggest part of the staff is elderly people - young people don't want to work in this industry	Growth of company and skills
Long mining history, evidence of successful RDI projects	UL doesn't exist factually	lack of sense/knowledge	Customers of Cuprum can become customers of the lab and BSUIN

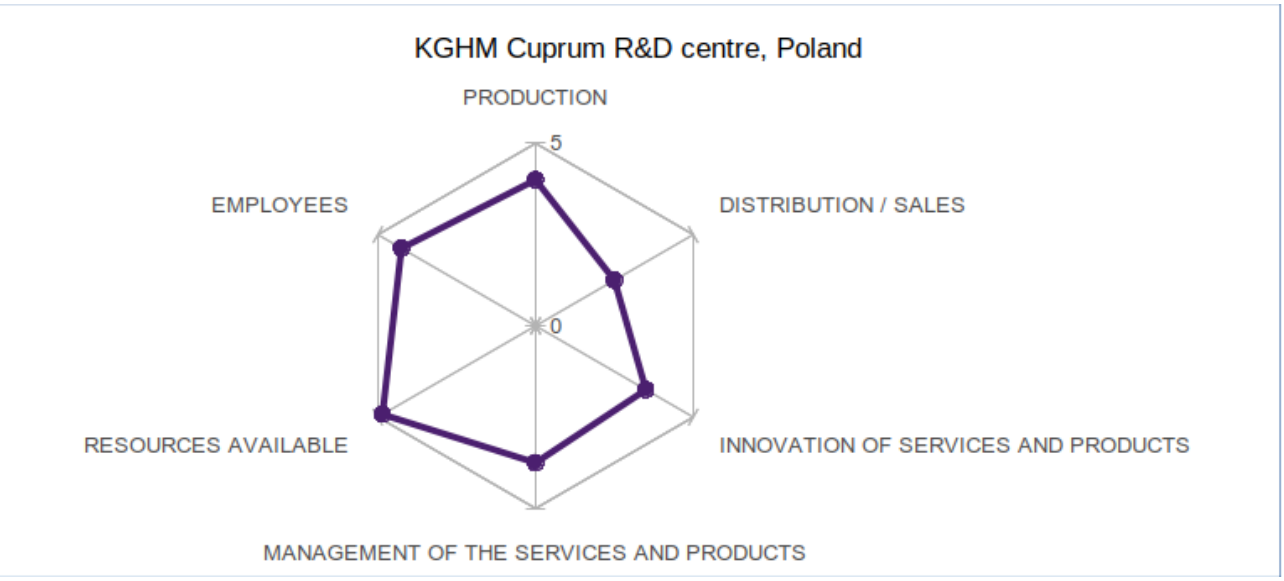
Long history	Not designed for research	seismic activity causing instabilities	A new approach for Business; saving costs in innovation management; new technology development opportunities; finding other energy sources for the generation (not only governmental funds)
Major mining company as a background resource	Paraseismic activity [must be moved to threats part]	roof stability+ seismic incidents (collapse)	Becoming an innovation hub for customers in growing Central and East European market
Innovative company	limited funding - big long-term governmental funding needed	electrical issues	establish strong research organizational support/lobbying
Possibilities for some dangerous experiments and find something new	social acceptance is low to open / development of new mine fields. Lack of resources for CUPRUM	lack of financing is a great issue in the future (lots of international project initiatives might be frozen)	clear strategy for the UL development
close solutions of the research labs to the production places (mines)	Mainly focused at mine production and not to additional business opportunities / services such as research UL development	there is a big need of additional financing for building the new lab, therefore the following aspects might be taken into consideration: stability issues, legal aspects, environmental protection issues.	using wider networking opportunities ("Raw materials day, European Minerals day")
hereby potential users and customers for mine basics	missing concept for internationalization	finding funds for the Uls	active collaboration in the BSUIN network :)
economy	production environment (it can disturb particular research projects)	Big competition with neighboring labs	using international projects and a base for thesis for students (both Master and PhD); ALSO involving foreign students.
active mine: working infrastructure, all safety & technical issues up-to date	production based mine	environmental trends (lots of restrictions regarding mines and its labs)	there is a synergy if UL will not be a separate / subsidiary company - it should be a part of Cuprum (UGHM PM) structure.
still mining going on	overall strategy for Uls development still in early stage	Political circles (regular rotations might affect management changes)	better mining equipment, new customers potential

Location	Underground facilities are not well very developed	Lack of Political support (government doesn't agree on policies regarding particular regions / companies)	new solutions / innovations in mine production (technologies)
great environment / many universities in the city & a lot of experts	Company policy changes	Changes of political situation	location --> identify mining areas for secondary use | strengthen geopolitical center
Strong research unit with related CUPRUM mine activities	Low internationalization in research area	Changes of policies / ownership	Big mine heritage & existing experience --> good basis to develop underground facilities for different purposes, e.g. tourism
CUPRUM has a great over ground resources: labs & quality people	The role of the UL is not clear	Political changes and regulations (environmental)	Diversification of funding sources and research topics
Perfect location	Is it in their plans? (UL)	Legal changes	Great location in Europe and cooperation potential with local underground facilities (other synergies and it is good basis to increase internationalization in research-industry field).
Different mining conditions	Independence of LAB to CUPRUM company; / possible conflicts of interest?	Dependence to Global Market price(s)	good marketing potential and support functions (great understanding and knowledge of UL sector as such)
Underground location of Labs	Big company which can bias long decision-making processes regarding various issues. Potentially not flexible structure for external services.	budgeting / prices: prices for companies could be lower	internal communication
depth of mines - different conditions on different mine levels	Long decision processes.	Not enough funding for research, too big staff costs (for high competence employees)	strategic+ financial+ operational PLAN for UL accepted by Board or some other body of owner
Unique environment	Image of existing mine can associate with danger	Poor results of researches at labs (lack of responsibility); financing issues (its overall conditions)	income diversification

experienced staff	Big corporate bureaucracy	Changes in Governmental and corporate policies	Higher acceptance of new R&D activities can make the mining production more effective.
existing mines with opportunity to install Uls	Depends on CUPRUM	Organic downturn in mining industry	more open for customers from Western markets
Variety of experiences (business, technical, research)	Limited research possibilities during existing mining		International (global) markets
Knowledge of different sites & geological environments	Dirty environment - bad working conditions		informing all political parties (political support might be encouraged)
CUPRUM KPGM experience in mining and research	Very bad accessibility		mining heritage; new innovations
openness for innovation	Long distance from CUPRUM [and [UGHN]]		preparing place for UL in waste management sector (this approach would not affect the production)
high skilled personnel in coal mining, good basis for research, new solutions in mining methods / equipment	Located in so-called a margin area in terms Baltic Sea Region		
coal mining and engineering know-how			
experienced staff			
in combination to experience in mining+ good connection to institutes in Wroclaw + Central Europe			

Source: *prepared and managed by Vilnius University team*

4.2. Chart 12. Spider diagram outcomes

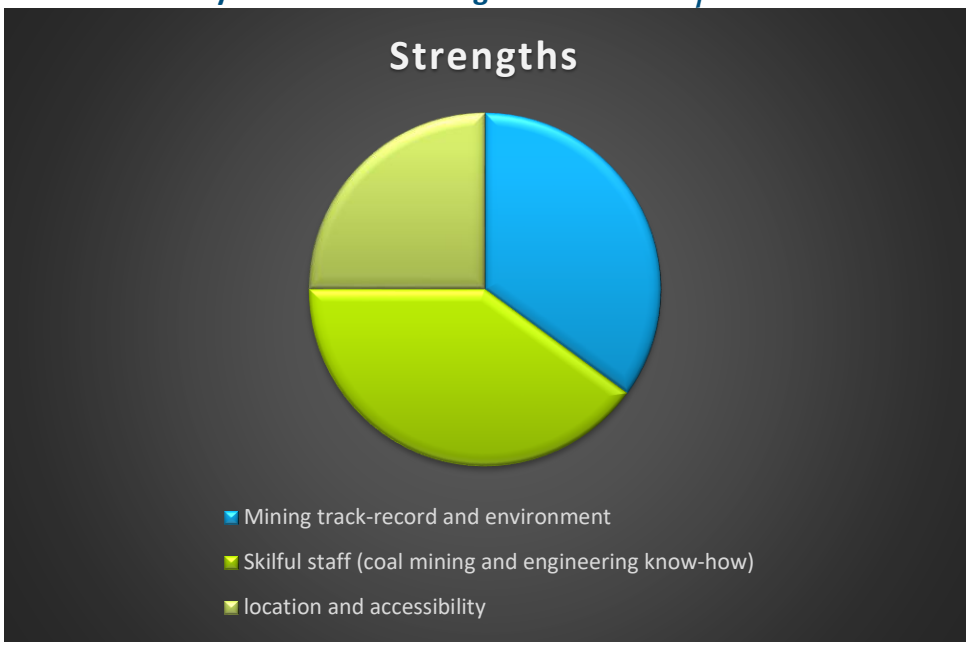


Source: *prepared and managed by Vilnius University team*

In order to sum up, as SWOT analysis and this spider diagram above (*prepared based on questionnaires (Annex), additional expert interviews, and discussions with potential customers above*) shows, the strongest part of these facilities of BSUIN conceptional UL in Poland are perfect resources (*incl. material, financial and human*), great team of professional and reliable (efficient) management. The mentioned combination obviously can assure good results of research and related production. Also, we it must be noted that development of science and innovation is quite sufficient. However, we see that there quite a lot of financial allocations need to be done in order to ensure marketing and international visibility.

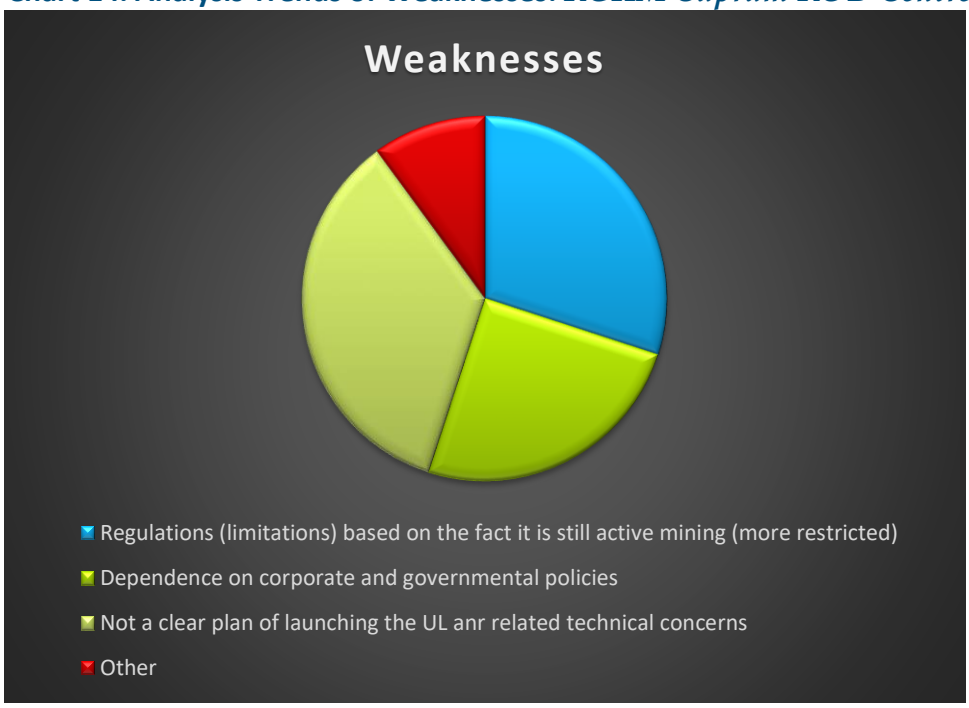
4.3. Business Analysis Conclusions

Chart 13. Analysis Trends of Strengths: *KGHM Cuprum R&D Centre* case



Source: *prepared and managed by Vilnius University team*

Chart 14. Analysis Trends of Weaknesses: *KGHM Cuprum R&D Centre* case



Source: *prepared and managed by Vilnius University team*

Chart 15. Analysis Trends of Threats: *KGHM Cuprum R&D Centre* case

Source: *prepared and managed by Vilnius University team*

Chart 16. Analysis Trends of Opportunities: *KGHM Cuprum R&D Centre* case

Source: *prepared and managed by Vilnius University team*

Firstly, the main suggestion before any conclusions is to launch a new UL inside of the current mine as soon as it is possible. After it is going to be installed it is strongly recommended to develop innovative lab(s), especially with a focus of its strongest knowledge and practical experience which would apply its technical parameters and physical conditions of this particular location.

Secondly, it is also needed to incorporate overall associated studies (from study programs to special research lines which would attract various scholars) and develop practice-oriented niche training, workshops, conferences, and other events.

Thirdly, it would be logical to accelerate an opportunity to organize special tours where people can see real-life copper mines and metallurgic plant processes. Also, the current salt mine is very impressive which could be a very attractive additional tourist spot of previously mentioned BSUIN touristic sub-network (see article 2), especially, considering that Southern Poland, in general, has already a prestigious international image of the "Wieliczka" Salt Mine.

5. Ruskeala, Russia[9]

Picture 7. Inside of Ruskeala mine (water installations).

MAJOR ROCK TYPE(S)

The dominant crystalline rock type in Ruskeala is marble. The age of these rocks is approximately 1.6 – 2.0 G years.

THE ORIGINAL PURPOSE, CURRENT USE AND FUTURE PLANS

The "Ruskeala" UL was organized for the test, design and construction of touristic destinations in old lost quarries and mines. The current use is for different methodological and technical development of the roof control, investigation of weak zones – which could be a danger for visitors and also environmental, conduct geotechnological, photogrammetry investigations of the

[9] *Basic information was used from official website www.bsuin.eu, which was officially provided by UL Partners.*

underground space etc. The aim is to transfer the experience to other historic mines and quarries in the territory of Russian Federation.

ACCESSIBILITY

The Ruskeala Mining Park can be reached by car from Petrozavodsk (about 250 km), from Sortavala (about 25 km), from Joensuu (Finland) – about 130 km. The nearest airport is located also in Joensuu. Most of the visitors come from Sankt-Petersburg by tourist buses.

OVERALL DATA AVAILABILITY

All data from the Ruskeala Underground Lab are stored in the Institute of Geology KRC RAS. Nowadays the data are under the transferring stage to databases. It is still available for Karelian researchers.

SPECIALISED KNOWLEDGE, SERVICES

Specialized knowledge in geology, geophysics, rock mechanics, rock engineering. Scientific and technical experts available in the Institute of Geology KRC RAS. Organization for guiding, planning and starting external projects including experimental services ranging from geophysical to tectonophysical study of the area, photogrammetry and other investigations are available in the Karelian Scientific Centre.

Picture 8. Data collection process during Ruskeala road-show.

5.1. S.W.O.T. table 4.

Strengths	Weaknesses	Threats	Opportunities
Sustainable business	weak presentation	Too many people	Great place for UL
Mining heritage	not enough hotels	Too far away	There is a great potential for cooperation with other parks/ULs
All 4 seasons	not friendly with disabled	Competitors	Karelian unique culture
Close to the border	local authorities	Replacement of invasion species	Local farming
Beautiful	alcohol lazy	Rock failure	Special Karelian birches
Strong content	no souvenirs	Change of legislation that might limit the usage of old mine areas	Finland near

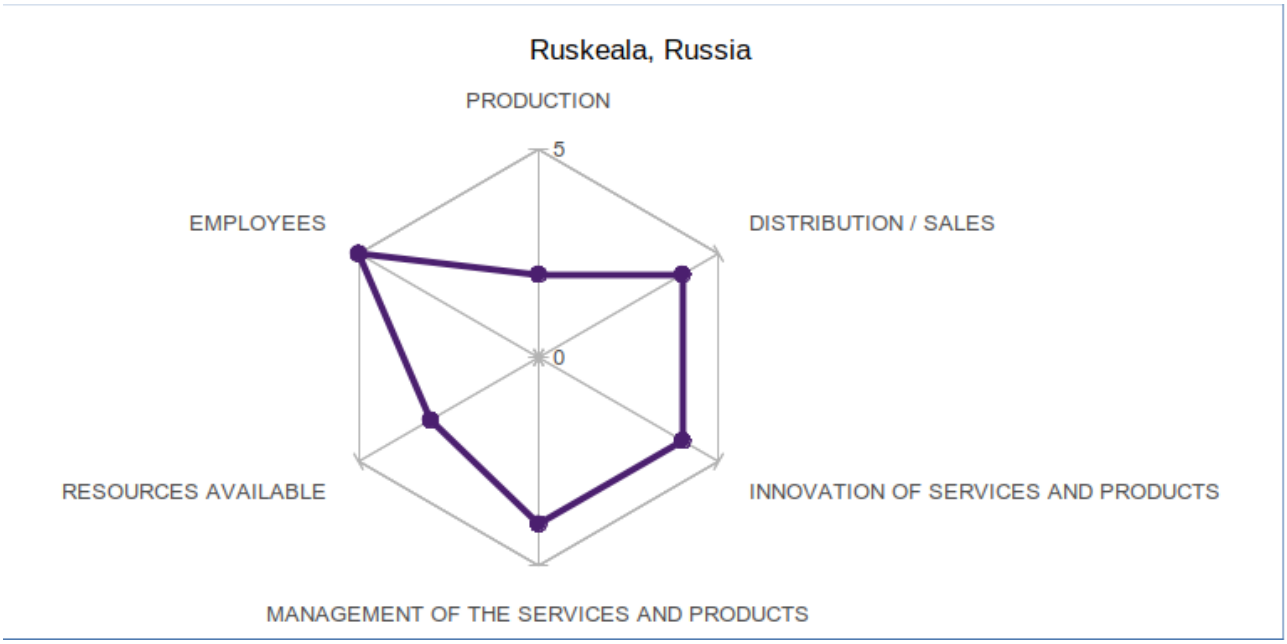
Finish (Karelian) heritage	limited hotel capacity nearby	Client might lose the attention and reduce the interest in a long term since it is in a quite far away distance, attractions are the kind of the same and visitors might get bored	Further growth (incl. European guests)
Strong content (history)	remote area (it is difficult to reach)	Lack of legislation	Clustering
Good support from local authorities and business established and well-known area	remote location (complicated access, rad not perfect for so many visitors)	Deformation of marble (not safe to go around)	Area can be expanded
Guests from big cities like Sankt Petersburg, for example	location a little bit too far away from the biggest cities	Not stable economic situation	Become leading adventure park in Karelia and South Finland (then more Finish visitors or other customers engaged)
Easy to access inside of mine	maybe not too many activities all around year, especially in winter period	Fiscal-stone fall down	Keep underground part (uniqueness) and add more attractions (in the water and outside the water) like adventure park on the trees, etc.
Different activities (big variety of activities)	weak guides	Accidents (not safe in many visitor areas, big risk of injuries, destruction of parts of facilities, etc.)	Creating a news business environment and related community in promising region
Not many competitors who open act in same area and region	legal status	Destruction of nature by bad people (hooligan visitors), respecting nature and more fences + video cameras are needed for this	New factory close by
Good natural stone	small place for rest	Politics	Enlargement of territory and rock park
Small depth of underground space	safety	Economics	Amazing tourism business related cluster opportunities
Diverse touristic attraction (mine lake, quarries, industrial heritage, nature activity, etc.)	infrastructure	Political challenges	International marketing attracting more foreign visitors with offers in English (also Finish).

Gorgeous landscape / beautiful nature	Safety	Young people might be not interested	Opening new underground routs
Accessibility	English language & signs	Economic situation	Organize "tourist village" & SCIENCE
Historical track record (heritage) very strong	Concentrating only on tourism (no other underground activities)	Legislation	New events (especially, regional / international / national)
A lot of interaction (many activities)	Lack of regulations helping the further development of UL activities	Russian political situation (potential sanctions, political isolation, and other potential limitations regarding international cooperation)	Virtual attractions and tools (especially for young people)
Environment	Distant location	Geopolitical instability	Close distance to Finland border
Easy access (good location)	Not safe infrastructure	Ecological disaster	More "hands-on" attractions for tourists (for instance, using smart technology combined with the nature, doing something underground with soft)
Stable conditions (no earthquake zone)	Not prepared for different age tourists	Poor visibility	Cross border business cooperation
Close to border	Only Russian guide	Poor availability during winter	Tourism
Beautiful nature	Oriented only for tourism, no other activities at the moment	The lack of information about this place to global community	More activities (attraction) for kids
Well-educated guide	Not oriented on foreigners (only Russian language present)	Political isolation	Well defined attraction
Beautiful views	Very shallow location	Limited opportunities for researchers	Economic development
Infrastructure (roads, good way to reach this place)	Accessibility (too far away)	Lack of LAB users	Unique environment (rocks) for experiments (lakes)

Large area of the mine (there is a place for future laboratory without major changes)	Underground instability	Stop of operations	Growing interest from tourists
Good opportunity to establish shallow lab (existing infrastructure could be used)	Lack of legislation	Legislation	Regional growth and development
Good tourist infrastructure	Good infrastructure	Safety installations	International marketing
Amazing entertainment facility during summer (vacation period)	No information in English (especially on a media, local signs, warnings, etc.)	Seasonality	Large are to grow
Strong leadership and vision in developing the area in whole	Remote location (quite challenging to access for international tourists)	Security issues (audits, kids, international standards)	More tourists from Finland and Sant Petersburg
Prepared for 4 seasons	Weak legislation	legal issues	School trips
Impressive historical match and heritage	Absence of mining specifics	permissions	Cuisine (local)
Nature	No English guide papers	political situation in Russia	Possible to make a "dinosaur park"
Great places around to eat	No map all tourist targets in about 10 km distance	the stop of developing current infrastructure	Water interactions
Good number of guides	Too far away from the airport	tourist might want to visit it only once	Bigger tourism potential
Clear positioning in a market (only tourism purpose based)	Underground with water inside	lack of careful maintenance (even if business is slow) will lead a) less tourists, b) dangerous situations	
		political situation	
		accidents	
		security adaptation	

Source: *prepared and managed by Vilnius University team*

5.2. Chart 17. Spider diagram outcomes



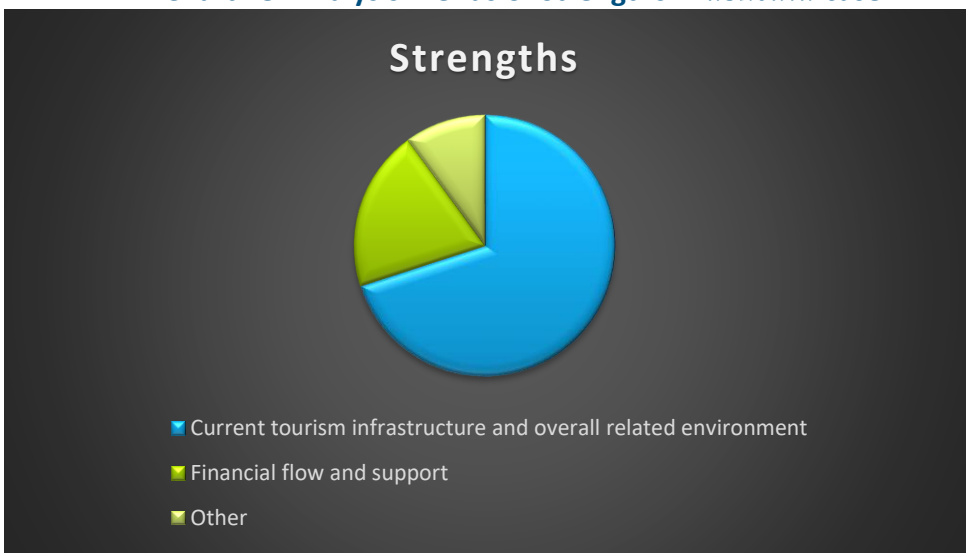
Source: *prepared and managed by Vilnius University team*

In order to sum up, as SWOT analysis and this spider diagram above (*prepared based on questionnaires (Annex), additional expert interviews, and discussions with potential customers above*) shows, the strongest parts of these underground facilities (potentially, really promising UL in the nearest future) are a great team of professionals and efficient management. Both of these features presuppose preconditions for accelerating the emergence of innovations in this location with unique historical background and infrastructure (technical parameters). Also, apart from the fact that BSUIN partner from Karelia could be identified as a leader in the annual flow of tourists, better international marketing and awareness could attract more international visitors and this impressive location could definitely enrich BSUIN niche touristic cluster (sub-network) by getting more synergies in this particular activity and (or) together with German *Reiche Zeche*

partner becoming one of its leading locomotives and attractions[10]. Finally, it is really a must to boost the development of scientific researches and laboratories there.

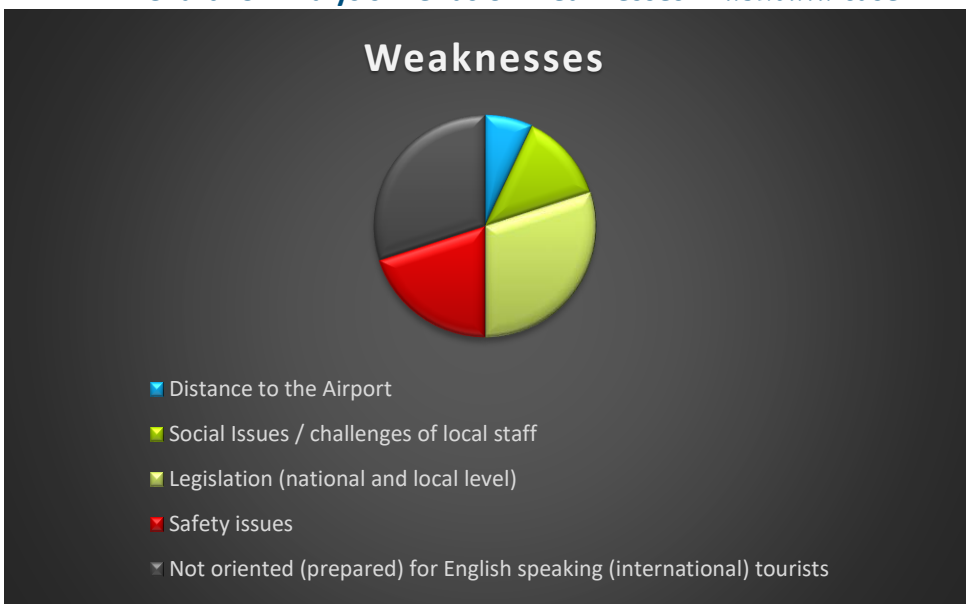
5.3. Business Analysis Conclusions

Chart 18. Analysis Trends of Strengths: *Ruskeala* case



Source: *prepared and managed by Vilnius University team*

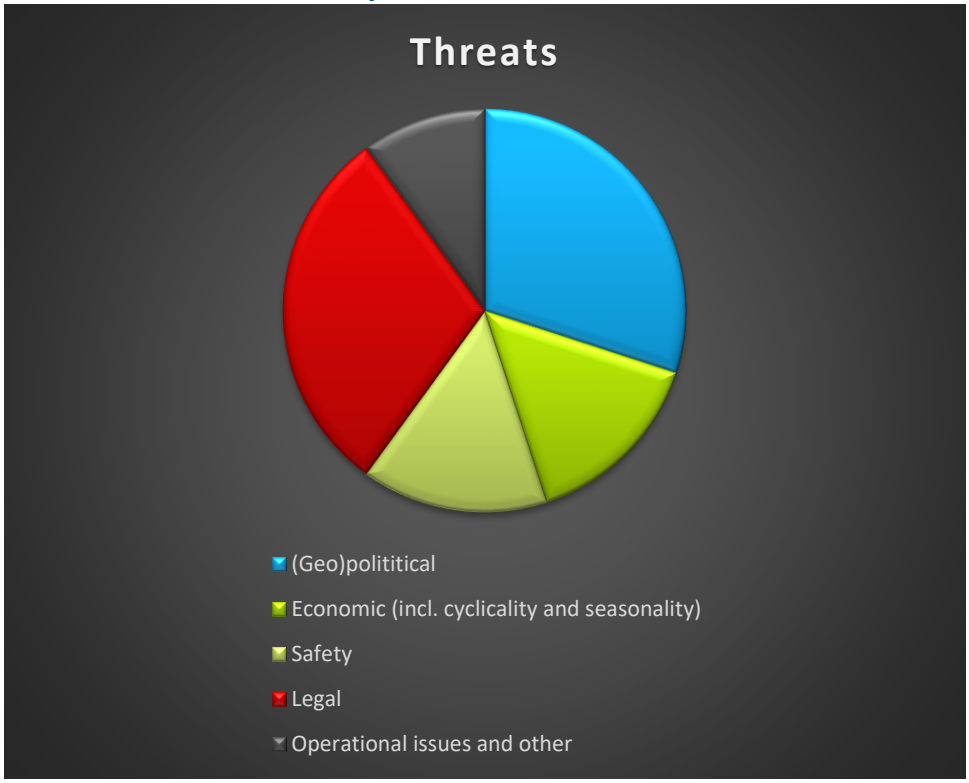
Chart 19. Analysis Trends of Weaknesses: *Ruskeala* case



Source: *prepared and managed by Vilnius University team*

[10] *As a matter of fact, Ruskeala is undoubtedly considered as the best practice example for other BSUIN partners in currently attracting local visitors to its facilities.*

Chart 20. Analysis Trends of Threats: *Ruskeala* case



Source: *prepared and managed by Vilnius University team*

Chart 21. Analysis Trends of Opportunities: *Ruskeala* case

Source: *prepared and managed by Vilnius University team*

Firstly, since BSUIN is the cluster of ULs and Russian BSUIN partners are now in fact suspended because of the lack of required regulation of ULs, it is necessary to use and escalate BSUIN as an opportunity and best practice example of benefits and future synergies in overall mining infrastructure and related researches and desirable innovations. Later it is needed to continue with BSUIN evolution and (or), parallelly, initiate some additional pilot projects of international researches that would physically generate the demand of existing UL in Ruskeala. This could help to persuade the local, regional and federal politicians to incorporate the best practice of BSUIN partner experience and, finally, issue the necessary legislation (or doing corrections in existing legal acts) and assure the efficient regulation of ULs.

Secondly, with great tourist infrastructure, Ruskeala could develop additional educational programs that would involve the whole family. Attracting all generations of visitors would escalate the emergence of the wider scope of researches and innovations based on the related environment and sectors.

Thirdly, the existing infrastructure can be adapted to student exchange programs, not limited to mining, geology, and engineering students, but also attracting various researchers from history and tourism professions.

Fourthly, as was mentioned before it is a great need to boost the scientific potential through cooperation with BSUIN partners and further development of scientific cooperation networks.

6. CALLIO LAB, FINLAND[11]

Picture 9. CALLIO LAB quarters.

MAJOR ROCK TYPE(S)

Granite bedrock, where the mine operation is based around massive vertical shaped volcanogenic sulfide deposit. The bedrock belongs to the Fennoscandia (Baltic) shield. Very little vibration impact from plate tectonics.

THE ORIGINAL PURPOSE, CURRENT USE AND FUTURE PLANS

Callio Lab is located in the Pyhäsalmi Mine, operated by First Quantum Minerals (FQM) The mine's main products are Cu, Zn and pyrite (FS4). The mining operations shall continue to the

[11] *Basic information was used from official website www.bsuin.eu, which was officially provided by UL Partners.*

end of June 2021. In the future, Callio Lab facilitates several types of actors, including research institutions and companies.

ACCESSIBILITY

All of the mine's tunnels are accessible with a truck from the 11 km long maintenance road extending to the bottom of the mine, down to 1.44 km depth
The fast elevator (3 min) from the surface to the main level (1.4 km). The maximum speed of the elevator is 12 m/s and person count are limited to 20 people.

OVERALL DATA AVAILABILITY

A rock mechanical study of the deep (> 1 km) part of the mine, done for the LAGUNA proposal is available at http://laguna.ethz.ch:8080/Plone/deliverables/laguna-lbno-site-investigations-deliverables/d7-geologicalmodelling/d7-geological-modelling/at_download/file

Inquiries about the availability of spaces to Callio https://callio.info, *contact* sakari.nokela@pyhajarvi.fi

SPECIALISED KNOWLEDGE, SERVICES

Quality system for visitors and a safe working environment down to 1.44 km. Large maintenance halls, restaurant, conferencing and social facilities on the main level at 1.4 km depth. An optical cable is available at practically all levels in the mine. GSM telephone network at the main level (1.4 km). A state-of-the-art micro-seismic monitoring network installed in the mine.

Picture 10. Data collection process during Oulu road-show (at University of Oulu).

6.1. S.W.O.T. table 5.

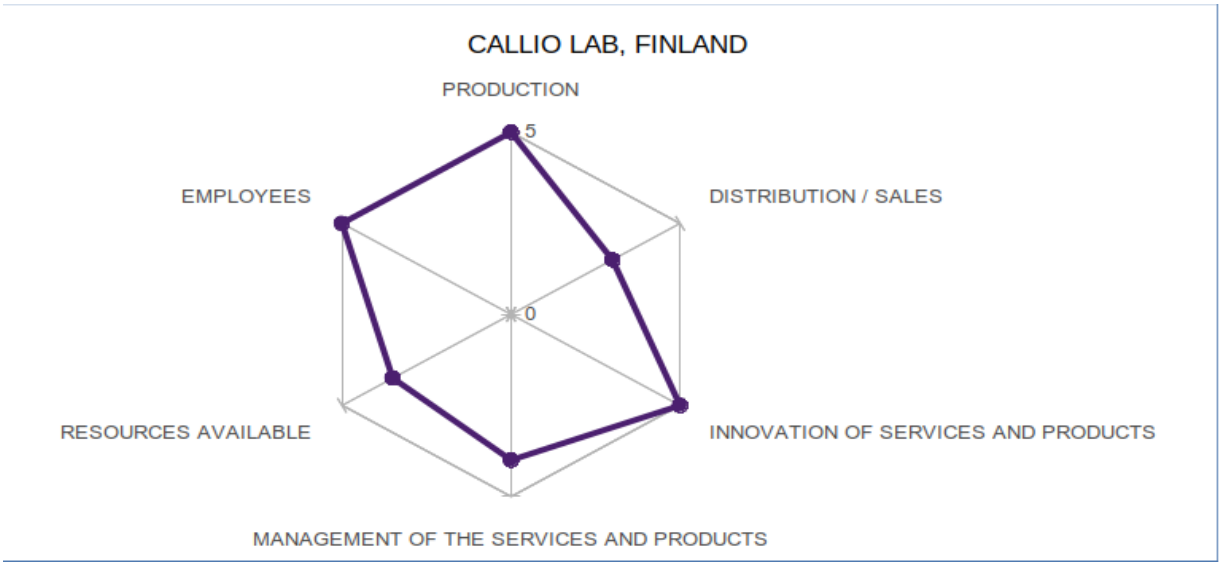
Strengths	Weaknesses	Threats	Opportunities
Great infrastructure	Far from the airport	Lack of financing	Amazing synergies with local business and public sector
Strong cooperation with university	Lack of governmental financing	Close to Russian Border (geopolitical threats)	Potential to develop local hub / specialized business incubator
Existing know-how and solid necessary track-record	Long way from the airport	Some safety challenges	Great potential of leadership of BSUIN
Support from local authority	Location	Lack of financing	Creative, unique and innovative solutions
Good shape of infrastructure	No big cities around	Not clear future	Family tours
Skillful staff	Uncertain situation regarding the future of existing underground facilities	Shrinking EU subsidies	interdisciplinary innovations
Big international experience	Location	Brain drain from small towns	Big potential to cooperate with local authorities
Strong EU funding background	Procedures (not flexible)	BREXIT tensions (general future EU funding situation)	Tourism promotion

Perfect shape of laboratories	Location	Potential legal restrictions	Event management
Great team	All clients need to travel quite far away	Environmental issues	Big conferences and concerts
Perfect synergies with University of Oulu	Accommodation challenges	Lack of financing	BSUIN potential
Strong laboratories	Traveling take too much time	Global economic crisis	Public Private Partnerships
Existing facilities	Depressing winters (too dark for visitors)	Global Financial crisis	Business incubator
Obvious support from local authority	Location	Lack of competitiveness	Perfect area for global hackathons focused in mining sector
Existing infrastructure	Too big distance from Western Europe	Intellectual property law issues	Russian clients
Efficient processes	Not enough entertainment for young staff members	Environmental issues	Bigger synergies with Russian clients
Super team	Too far away	Safety issues	Tourism promotion
Comfortable infrastructure	Location	Frozen BSUIN initiative	Overall tourism sector related researches
Stable and modest physical parameters	Too small surrounding towns	Geopolitical turbulences	BSUIN tourism network, bigger quantities of tourists
Beautiful neighborhood	Cold surrounding climate	Financial obstacles	More pilot project with continuation
Existing facilities	Distance	Insolvency issues	Successful marketing campaign of BSUIN
Good shape of infrastructure	Location	Not enough synergies inside BSUIN	Underground Facilities Business incubator
Enthusiasm of leaders	Hard access	Brain drain to larger cities	Underground accelerator
Positive image	High salaries	Financial challenges	Business Incubator
Team of experts	Growing budget	Geopolitical challenges	Regional UL hub
Positive feedback from customers	Too far away from major cities	Too close to Russian border	Leadership in BSUIN

Good references	Existing restrictions due to current activities of mining	Hart to attract investments	More intensive synergies with University of Oulu
Clear, aggressive and promising vision	Location	BSUIN might stuck	Mutual programs with University of Oulu and neighboring town colleges, vocational centers
Impressive, unique infrastructure	Extra motivation needed for younger staff members	Not enough synergies among BSUIN partners	Public private partnerships (PPP)
Impressive infrastructure	Distance from major towns	Financial issues	PhD candidates specialized in this environment
Skillful team	Remote location	Overall insolvency issues	Specialized academic programs
Prepared infrastructure	Too far away from Western Europe	Financing hurdles	Additional tourist flow from BSUIN
Efficient pilot initiatives	Unknown location	Dirty actions of external competitors	BSUIN potential
Strong leadership	accessibility	Mobility issues	International big corporate clients
Necessary enthusiasm	No direct flight	Legal restrictions	Private financial initiatives (PFI)

Source: *prepared and managed by Vilnius University team*

6.2. Chart 22. Spider diagram outcomes



Source: *prepared and managed by Vilnius University team*

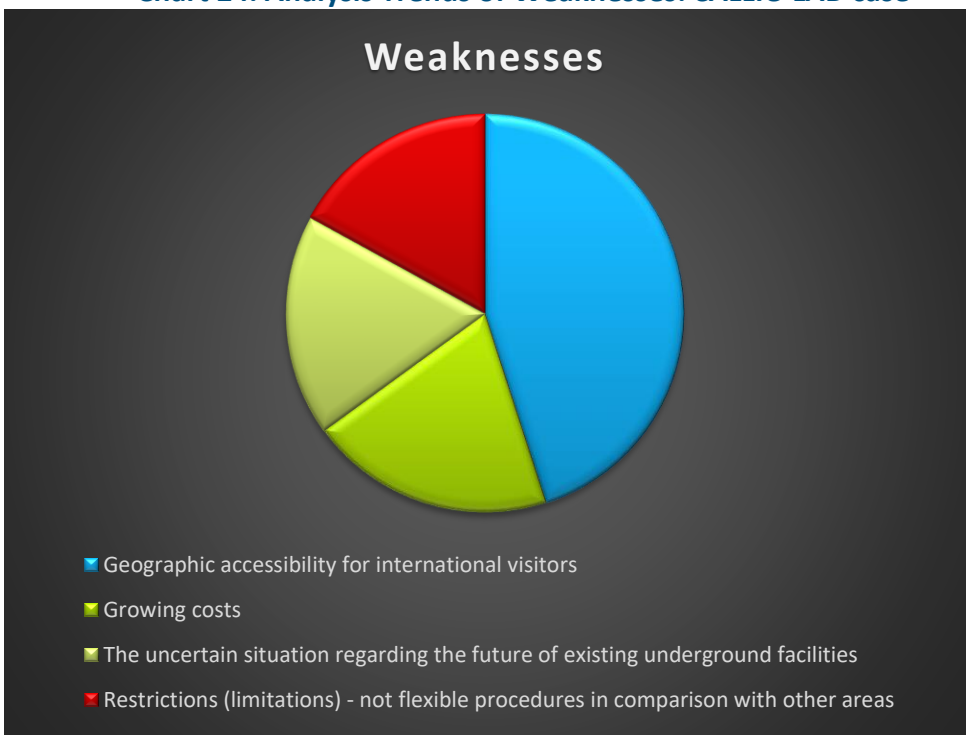
In order to sum up, as SWOT analysis and this spider diagram above (*prepared based on questionnaires (Annex), additional expert interviews, and discussions with potential customers above*) shows, the strongest part of *CALLIO LAB* is an outstanding team of professionals which is obviously delivering perfect results of its research activities. Also, it must be noted that, according to the representatives of *CALLIO LAB*, it does not have any environmental accidents so far and have not had in the last 60 years mine in operation. Safety and environmentally friendly approach remain as the top priority for decades. In addition to this, it should be noted that there is a strong focus on innovation and related processes are being managed efficiently. On the basis of good results, the material base (existing infrastructure) for the development of future activities should be strengthened (enhanced). Finally, like the cases of other BSUIN partners here as well more attention must be paid to marketing and sales in order to achieve both its own intellectual development and global expansion of BSUIN and boosting competitiveness as a network leading partner.

6.3. Business Analysis Conclusions

Chart 23. Analysis Trends of Strengths: *CALLIO LAB* case

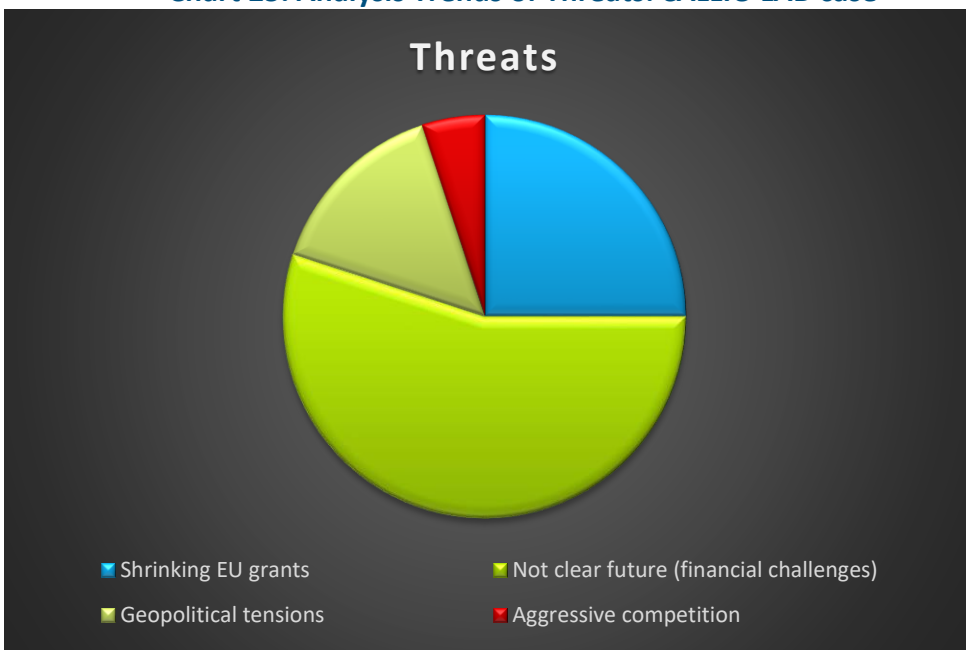
Source: *prepared and managed by Vilnius University team*

Chart 24. Analysis Trends of Weaknesses: *CALLIO LAB* case



Source: *prepared and managed by Vilnius University team*

Chart 25. Analysis Trends of Threats: *CALLIO LAB* case



Source: *prepared and managed by Vilnius University team*

Chart 26. Analysis Trends of Opportunities: *CALLIO LAB* case

Source: *prepared and managed by Vilnius University team*

First of all, in order to maintain the leadership of BSUIN also boost the potential to compete globally in a long term, *CALLIO LAB* having its impressive and contemporary infrastructure[12], should further expand its efforts of participation in global scientific cooperation networks.

Secondly, in cooperation with its contemporary, flexible and progressive founder University of Oulu it could develop high-level study programs with a clear focus on creativity and innovation including practical implementation of interdisciplinary innovations.

Thirdly, *CALLIO LAB* should support and join the mentioned sub-network of BSUIN in touristic direction (see Articles 2 and 5). For this reason, it should create an attractive educational tour for all generations. This initiative would allow it to achieve both (1) attracting full scale of family members as local and international visitors and (2) accelerating and boosting related researches innovations in this sector.

Fourthly, as a team and content leader of BSUIN *CALLIO LAB* could stimulate and accelerate main strengths BSUIN and the further pilot benefits of collaboration could be, for instance, EU funded joint R&D projects, also supply of various laboratories, technologies and facilities, capacity building of highly skilled staff. Also, in cooperation

[12] *It must be noted that the Pyhäsalmi mine is less than 2 hours away from five airports (Oulu, Kokkola, Kajaani, Kuopio, Jyväskylä), of which Oulu is the second busiest airport in Finland immediately after Helsinki and has more than 1 million transit passengers annually. You can fly from Helsinki to Oulu in an hour and by car to Pyhäsalmi in less than two hours. Finland is a country of long distances and small towns, where only about 5.5M inhabitants actually live. From Oulu it is less than 2 hours to Pyhäsalmi mine door to door, Oulu is the oldest city in Northern Finland and the fifth largest in Finland in terms of population, and the fourth largest urban area in whole Finland.*

with other BSUIN partners it could lead joint educational activities, students, scholars and academic staff exchanges, joint programs, hands-on training in different settings.

•

The strategy of CALLIO LAB is to focus on business development with companies and enterprises first. Since the competition to get EU funding is harsh, and later it requires huge administrational efforts to manage it effectively, CALLIO LAB should continue initiating various public and private partnerships (private financial initiatives) in commercial research area. Also, it must be oriented in incubating and accelerating viable businesses such as SME company pilots, trials, business to the mine.

7. Khlopin, Russia[13]

Picture 11. Khlopin quarters.

MAJOR ROCK TYPE(S)

Cambrian Clay

THE ORIGINAL PURPOSE, CURRENT USE AND FUTURE PLANS

Now in underground laboratory measurements of tritium on the TriCarb 3100 installation are constantly taken. Also, there are three gamma-spectrometer complexes with powerful protection against an external background.

ACCESSIBILITY

The laboratory is located practically in the very center of St. Petersburg. 20-30 minutes by metro from any railway station and about 1 hour from the airport (35-40 minutes by taxi to the center, then down the escalator to the underground lobby "Gostiny Dvor".

OVERALL DATA AVAILABILITY

All research data and research done in the underground laboratory, are part of the reports in scientific and commercial contracts. Data is available for customers and contractors. There are several publications available in Russian.

[13] *Basic information was used from official website www.bsuin.eu, which was officially provided by UL Partners.*

SPECIALISED KNOWLEDGE, SERVICES

Any specialized knowledge in the field of geology, hydrogeology, geochemistry, groundwater chemistry, geophysics, mining mechanics, material science of Cambrian clays, etc. are not available, since the subway is a civilian object of a particular category

Picture 12. Sankt Petersburg City.

7.1. S.W.O.T. table 6.

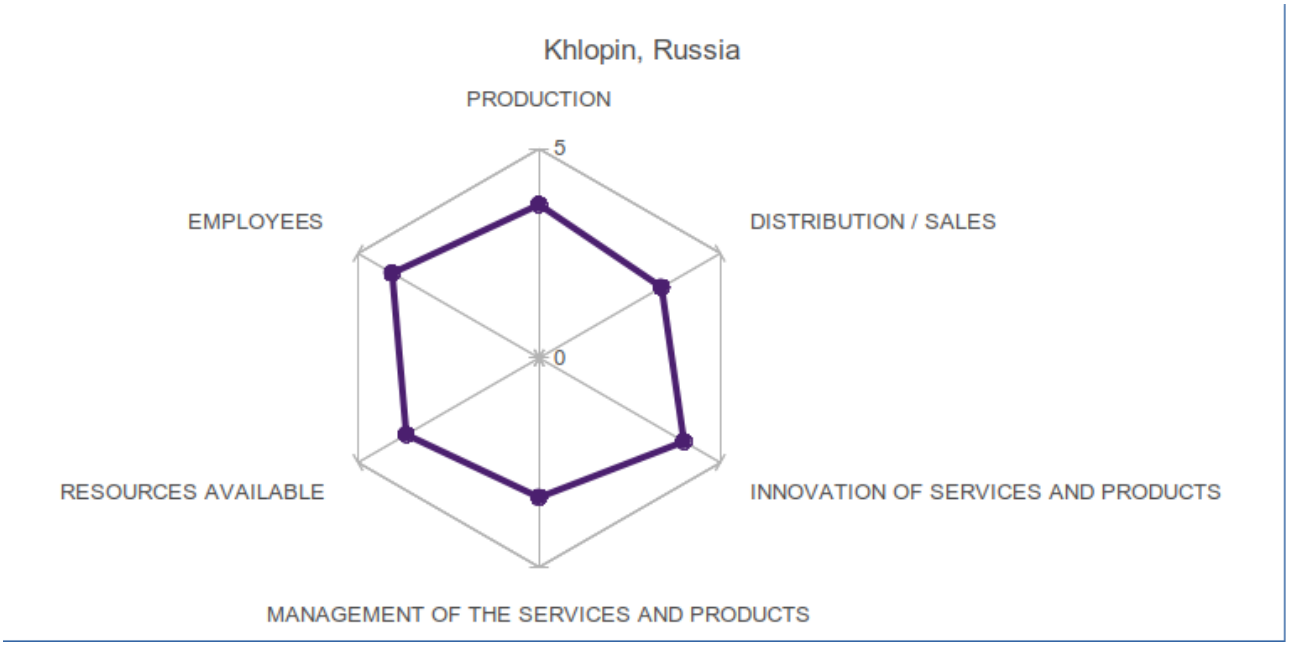
Strengths	Weaknesses	Threats	Opportunities
In the middle of megapolis (Sankt Petersburg)	No proper regulation of ULs	Financing	BSUIN potential
Supreme location	Need for the first best practice example	Legislation	Bigger / deeper infrastructure
Easy to access	Weak image of UL facilities in Sankt Petersburg	Worse legislation / regulation	BSUIN synergies
Many flights from all over the world	No regulation	Geopolitical issues	General need for synergies with Western partners
Location	The smallest in BSUIN	Political issues	Public Private partnerships (PPPs)
Accessibility	Very small capacity	Political isolation	Private financial initiatives (PFI)
Governmental support	Too little staff	Legal regulation stagnation	BSUIN potential

Easy to come	Not enough staff	Another global crisis	Russian subsidies
In the middle of the town	Marketing	Insolvency issues with clients	BSUIN potential
Charismatic leaders	No proper marketing at the moments	Not enough clients	Better communication
great Location / accessibility	, Lack of legal background / legislation	Global financial (based on COVID 19) crisis effect, etc.)	Scale of economy of BSUIN network

Source: *prepared and managed by Vilnius University team*

It must be noted that due to the intensive agenda and specific situation (status) of Khlopin we did not have a chance to organize a separate roadshow of data collection in Sankt Petersburg. However, we used all the same questionnaires, communicated with all necessary stakeholders (including potential customers) by using emails, (video) calls and meeting its representatives in other study visits of BSUIN partners, so most of the information was successfully collected as well and business analysis completed in terms of the entire BSUIN potential.

7. 2. Chart 27. Spider diagram outcomes

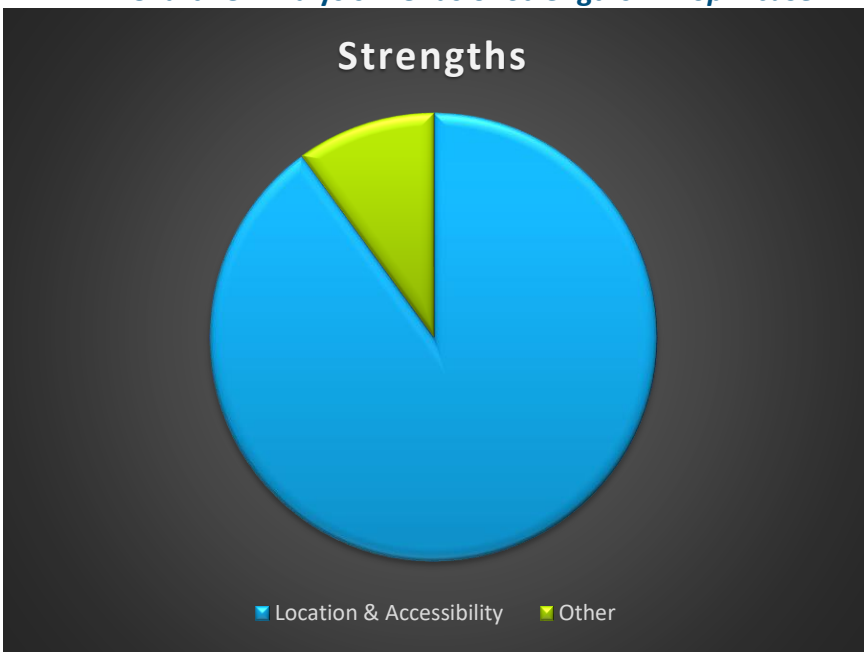


Source: *prepared and managed by Vilnius University team*

In order to sum up, as SWOT analysis and this spider diagram above (prepared based on questionnaires (Annex), additional expert interviews, and discussions with potential customers above) shows, the strongest parts of *Khlopin* UL are experienced staff and innovation of services and products. Resources, management, and commercial elements are considered in also above average levels. However, the main issue in *Khlopin* is legal restrictions just like it was in *Ruskeala* due to the fact that the Russian Federation is quite limiting research activities in former mining infrastructure.

7.3. Business Analysis Conclusions

Chart 28. Analysis Trends of Strengths: *Khlopin case*



Source: *prepared and managed by Vilnius University team*

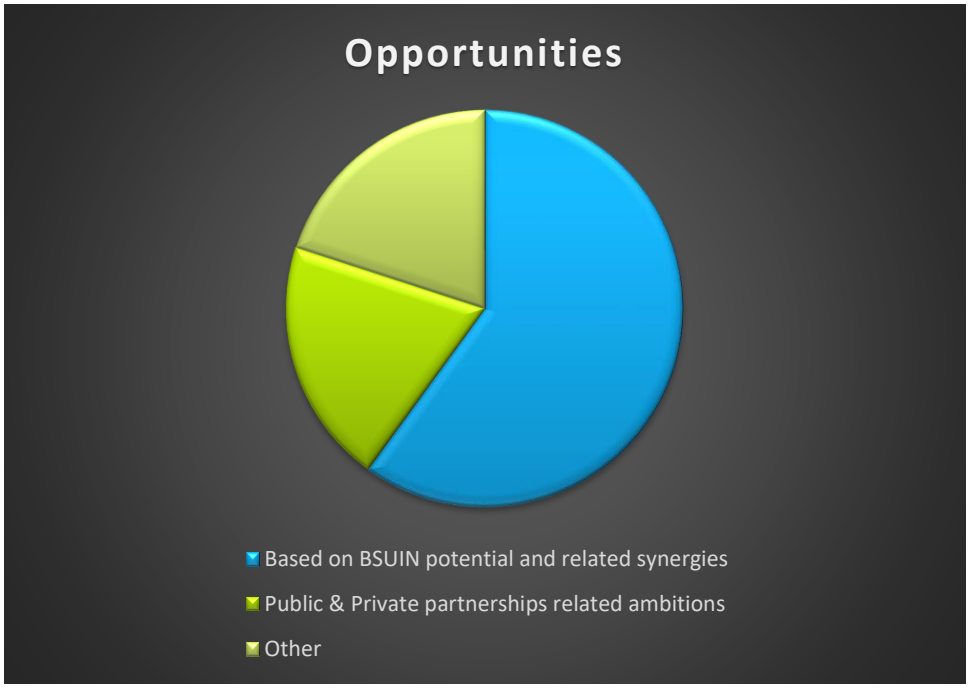
Chart 29. Analysis Trends of Weaknesses: *Khlopin case*

Source: *prepared and managed by Vilnius University team*

Chart 30. Analysis Trends of Threats: *Khlopin case*

Source: *prepared and managed by Vilnius University team*

Chart 31. Analysis Trends of Opportunities: *Khlopin case*



Source: *prepared and managed by Vilnius University team*

Firstly, as we can see on Chart 28 above, "Location and Accessibility" related were dominating among the emphasized strengths of Khlopin UL. This trend shows a uniqueness of this area in terms of potential attraction and related circumstances. The fact that this UL is located in the center of Sankt Petersburg megapolis with our more than 5 million population is challenging and limits various physical infrastructure development scenarios. However, in BSUIN perspective it could identified as institutional representative and pilot testing lab of various business requests from more than 145 million population market. And in a long term it could make a sufficient added value to the BSUIN in different administrational (*including HR, grant management, etc.*), innovation dissemination and commercial projections.

Secondly, Khlopin should cooperate with Ruskeala colleagues and ensure the legal lobbying necessary for efficient and full-fledged functioning of its UL, including opportunities to develop innovations and researches in a full mode.

Thirdly, it should consider joining BSUIN initiatives in the areas of mutual EU granted R&D projects, the supply of various laboratories, technologies and facilities, highly skilled staff. Also, joint educational activities, students, scholars and academic staff exchanges, joint programs, hands-on training in different settings should be on the top of Khlopin UL short-term and mid-term period agenda.

Finally, considering that Sankt Petersburg is one of the most beautiful cities in Europe and attracts millions of tourists every year, Khlopin, which is located in the heart of this megapolis should join the BSUIN mining route for tourists (see article 2 and 5), which will attract more visitors to BSUIN partner locations. In parallel, this activity will assist as

additional dissemination and public awareness channel encouraging students, scholars, academic staff and other possible institutional partners to choose engineering specialties and joining BSUIN activities in various ways.

Conclusion

In summary, it must be noted that comparing all 6 ULs of BSUIN in business terms is a very sensitive task because, as it is clearly seen in this business analysis, in Germany, Sweden, and Finland BSUIN partners have already existing ULs with solid professional, experience and impressive global level credentials and, in terms or BSUIN, ULs in Russia and Poland are basically the concepts and good will (conceptional ULs). However, there is a great potential and demand for synergies noticed. If we speak about global trends, related opportunities, and challenges in UL area obviously all 6 BSUIN partners are facing a huge competition while trying to attract global market leaders, private investments, and (or) even getting grant funding. BSUIN generates an opportunity to persuade both (1) private corporates (including institutional investors) and (2) various grant/subsidy management & supervision authorities to allocate its strategic investments into this underground-infrastructure-based cluster because this structure is covering various technical parameters, know-how, research areas, and entire Baltic Sea Region. In BSUIN, (as a cluster) the competitiveness to attract global business partners is much bigger than doing it separately. From the underground facilities networking, branding and benchmarking point of view BSUIN is on the greatest regional initiative. And, above all, despite the different settings at the ULs, the common need at the moment is to increase the visibility and expand the use of BSUIN in a long term by generating an added value to all its partners and later ensuring sufficient synergies among current and future members of this unique and niche business and research cluster.

Annex (Questionnaires used during business analysis)

1 Customers

1.1 What is the core value of services and products?

1.2 Is the product / service presented attractively? What should be improved?

1.3 Is the sales process well-organized / managed? Is it annoying?

1.4 Are products / services in line with global trends and / or needs in the region?

2 Employees

2.1 What are the aims of the organization?

2.2 Is there enough resources to achieve results? What's missing?

2.3 How is the value creation process organized?

2.4 Is the organization well managed? Is it annoying?

2.5 Are you satisfied with the motivation system? What should be improved?

3 Shareholders

3.1 How are the organization's goals communicated to employees?

3.2 Is the system of continuous improvement implemented in the organization and does it work?

3.3 Are existing products / services in line with global trends and / or regional needs?

3.4 How the activities of the organization are supported by local authorities.

1. How do you assess the current state of the CREATION/PRODUCTION and SALES/COMMERCIALISATION parts (please refer to the diagram)?

Grading scale from 1 (poor – developed very poorly) to 5 (excellent – very well developed)	1	2	3	4	5
1.1. Assessment of the CREATION/PRODUCTION part					
1.2. Assessment of the DISTRIBUTION part					

2. Please specify the most important specialties of the EMPLOYEES [scientists and researchers] and assess their qualification.

Grading scale from 1 (poor – low, almost non-existent) to 5 (excellent – there are many of them and they are highly qualified)		1	2	3	4	5
2.1.	Assessment of professional skills of ..... (insert the specialty)					
2.2.	Assessment of professional skills of ..... : (insert the specialty)					
2.3.	Assessment of professional skills of ..... : (insert the specialty)					
2.4.	Assessment of professional skills of ..... : (insert the specialty)					
2.5.	Assessment of professional skills of ..... : (insert the specialty)					

3. How do you assess the RESOURCES AVAILABLE (infrastructure, equipment, funds, legislative framework) for the creation of a new product?

Grading scale from 1 (not available at all) to 5 (fully sufficient)		1	2	3	4	5
3.1.	Overall assessment of the sufficiency of INFRASTRUCTURE available for the creation of new services and products					
3.2.	Assessment of the LEGISLATIVE FRAMEWORK for the creation of new services and products					
3.3.	Assessment of FUNDING ALLOCATED BY THE STATE to the creation of new services and products					
3.4.	Assessment of ATTRACTING PRIVATE FUNDS (income from sales, business, bank loans, etc.) for the creation of new services and products					

4. How do you assess the MANAGEMENT OF THE SERVICES AND PRODUCTS CREATION PROCESS?

Grading scale from 1 (managed very badly) to 5 (managed very well)		1	2	3	4	5
4.1.	Assessment of the PLANNING AND ORGANISING (preparatory work) o creation process of services and products					
4.2.	Assessment of the MOTIVATION SYSTEMS of the participants in the creation pr of services and products					
4.3.	Assessment of the skills of TEAMWORK of the participants in the creation proc services and products					

5. How do you assess the current INNOVATION OF SERVICES AND PRODUCTS and their CREATION?

Grading scale from 1 (very poor) to 5 (very high)		**1**	**2**	**3**	**4**	**5**
5.1.	Assessment of INNOVATION (new ideas, the use of new technologies) in the creating of services and products					
5.2.	Assessment of the level of COMPETITIVENESS of services and products in international markets					

6. How do you assess the current level of DISTRIBUTION/SALES of services and products?

Grading scale from 1 (very poor) to 5 (very high)		1	2	3	4	5
6.1.	DISTRIBUTION/SALES level [of services and products] for the LOCAL market					
6.2.	DISTRIBUTION/SALES level [of services and products] for FOREIGN markets					
6.3.	MANAGERS' [of services and products] skills to DERIVE INCOME from the products being distributed					
6.4.	MANAGERS' [of services and products] skills to ATTRACT FUNDS for the creation of new services and products					
6.5.	DISTRIBUTION/SALES level [of services and products] as compared with that in FOREIGN MARKETS					
6.6.	TARGETED SUPPORT OF THE GOVERNMENT [of services and new products] to DISTRIBUTION/SALES					