Industrial Symbiosis Practitioner Training

Evaluation and Assessment Summary Report

Reported by:

Leading partner: Linköping University (PP10)

Authors: Murat Mirata, murat.mirata@liu.se
Mats Eklund, mats.eklund@liu.se

Date: 16 November 2021

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1 Introduction

As part of the Baltic Industrial Symbiosis project "Practitioner[1] Training Programs" (PTPs) were developed and delivered by Linköping University (LIU) in cooperation with Roskilde University and other project partners. These aimed at building capacity in partner regions and countries by improving the knowledge and capabilities of practitioners from key stakeholder groups so that they can more effectively engage in, and contribute to, industrial symbiosis practices and programs.

The contents of the PTPs were informed by an "needs and capacity assessment" study conducted with focus on project regions. Whereas the PTPs were originally planned to take place through on-site, face-to-face interactions, due to social distancing and travel restrictions imposed by the Covid-19 pandemic, the programs were re-designed and delivered through on-line means and interactions. Going beyond project's initial targets[2], a total of six training programs were completed, one in every partner country, between September 2020 and October 2021, in which 86 trainees took active part. Number of participants taking part in different PTPs is shown in Figure 1.
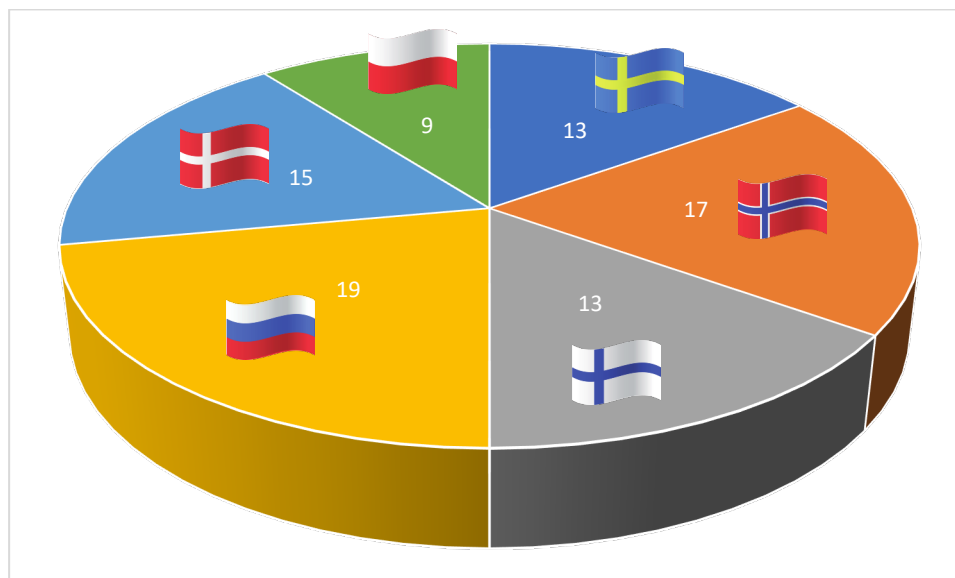

Figure 1: Number of participants taking part in different PTPs.

These PPTs were monitored and evaluated for their impact, strengths, and improvement potentials, and the received feedback was already used in a formative fashion within the project. The main purpose of this short report is to communicate the findings of this evaluation. Before moving into the details of the evaluation, a basic overview of the PTPs is provided in the next section.

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[1] Originally these programs were labelled "Executive Training Programs". However, in line of the feedback received from the first training program in Denmark, the title has been changed to "Practitioner Training Programs" as the word Executive was considered misleading (implying the training could be only for the top managers in businesses rather than decision makers from diverse organizations).

[2] Project's target was to deliver five training programs in main partner countries and to train a minimum of 60 individuals. The commitment was to make the training material available to the Russian project partners so that they could arrange a training of their own. Following a series of consultations, it was agreed for LiU to deliver the training in St Petersburg as well.

2   Structure, Contents and the Processes of the Training Programs

To improve their utility, the PTPs were designed to cover key topics of relevance, have numerous elements for interactivity, and include "applied" parts that offer interested participants an opportunity to start using their knowledge and ideas for practical action. Accordingly, the training programs were structured in two main parts as covered in further detail below.

2.1   Part 1 – Main introduction

This first and main part of the training aimed to provide comprehensive generic knowledge on key aspects of industrial symbiosis practices and developments. It also included interactive elements for improving context-specific knowledge and relations and for enhancing skills and experiences related to selected facilitation techniques.

Determination of the contents for this part was guided by a comprehensive review of needs relevant for supporting Industrial Symbiosis (IS) programs and practices, where input from literature and practical experiences were used. These were further expanded and refined through a collective dialogue with project partners. With the help of a "capacity and need assessment[3]" study, the relevance of importance of the needs for the project contexts were validated and refined, after which the key topics to include in the training were selected. These topics were covered in detail through different on-line interactions spread over three days (3 hours every day[4]). Part of these were in the form of thematic presentations by experts from Linköping and Roskilde universities. These focused on the following:

- Key societal sustainability challenges and the need for a resource transition;
- Selected challenges to bio-based and circular developments;
- Introduction to the IS concept and its value creating mechanisms;
- Operational examples of industrial symbiosis practices and networks;
- Environmental-, business-, and socio-economic benefits of IS;
- Determinants of IS developments with focus on techno-physical; information and knowledge related; organizational; economy and market related; social, and; political factors;
- Assessment of performance in IS practices and networks;
- Approaches and tools for facilitating IS developments;

(●: Day 1; ●: Day 2; ●: Day 3)

Each of these were followed by a Q&A part, where the questions from the participants were answered and their reflections were discussed.

During registrations, participants provided input on their knowledge levels prior to the training by filling a simple form. For every PTP, the number of participants with little or no knowledge in key areas was significant. Relatedly, the training contents for each context were set up for the lowest knowledge level and all of the topics above are included in all PTPs – with minor customisations (e.g. in terms of operational examples discussed). Instead, the detailed program of the training was communicated in advance, allowing participants with more advanced knowledge (and also others) select the parts they wanted to follow.

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[3] Detailed findings from this study is available in project output D 3.1. "Industrial symbiosis related capacities and needs in project regions – Results of the initial assessments".

[4] In the first training in Denmark took place in the form of two times three hour interactions. The feedback from the participants indicated the need to allocate more time, and relatedly a 3 day x 3 hours format was adopted in the remaining trainings.

2.1.1 Utilising/profiling contextual work and competencies

Every PTP is customized through parts where contextual knowledge and experiences are shared. Local/regional actors, identified through dialogue with local project partners, are given the stage and inform the participants about their past or ongoing work, their plans, related to IS developments and emphasise their achievements as well difficulties. While some of these contributions take place in the form of presentations, others are in the form of a dialogue with main trainers around pre-selected questions. These parts enable the trainings to make use of local/regional knowledge and expertise and helps disseminate information about good practices. Following contextual contributions were included in different PTPs:

- Presentation on "Dialogue and screening approach to identify synergistic opportunities" by Per Möller of Kalundborg Symbiosis (PTP in Denmark);
- Dialogue on "Industrial symbiosis drivers and challenges in Finland" withTuomas Pussila, Director of Industrial Circular Economy Center, (PTP in Finland)
- Dialogue on "Mapping industrial residuals" with Teemu Saralampi of Digipolis (PTP in Finland)
- Dialogue on "Role of municipalities to support IS" with Morten Solstad of Orkadals region. (PTP in Norway)
- Presentation on "promoting industrial symbiosis in Levanger Municipality" by Håkon Okkenhaug of Levanger municipality (PTP in Norway)
- Presentation on "IS facilitation experiences around St Petersburg" by Evdokia Lomagina of Tyreman group (PTP in St Petersburg);
- Presentation and dialogue on "Living labs for industrial symbiosis" by Per Mhyrén of Paper Province (PTP in Sweden)

2.1.2 Interactive elements of training programs

PTPs also included a range of interactive activities, which aimed to deepen, contextualise and apply knowledge, to provide experiences and enhance skills, and to enhance collective understanding and alignment. An overview of these is given below.

Group discussion: Multiple benefits of IS:
After being introduced to the concept of IS and its value mechanisms, in smaller groups participants discuss potential benefits of IS for the environment, for businesses and for the societies at large. Groups then report the highlights of their discussion to the entire group. afterwards. This activity helps the trainees to start improve their understanding of the benefits of IS which they can communicate in the future to generate interest from different societal actors. Their ideas from these discussions are later endorsed, and often expanded, when selected operational IS examples, that demonstrate a wide range of benefits of the concept, are presented.
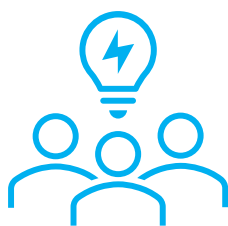
Group discussion on the enablers and barriers of IS:

In this activity actors identify discuss multiple factors that can support or hinder IS developments in smaller groups. Similar to the previous exercise, participants discuss their views in smaller groups, and share their key findings in a mentimeter survey. This sets the foundation for "development determinants of IS" presentation of the second day where participants' ideas are endorsed, elaborated on, and expanded through presentations by experts.

Image: Freepik.com

Workshop: Influencing IS determinants – who can do what?

After being introduced to a diverse range of inter-connected development determinants in detail, the participants perform a small workshop in smaller groups, where they think about, and reflect upon, the roles different actors, including their own organization, can play in creating more supportive development conditions. Participants present and share their individual and collective ideas on a digital whiteboard – which is accessible to all trainees (an example whiteboard with ideas created during the training in Sweden is given in Figure 2). This activity intends to improve understanding of the diversity of stakeholders who may need to be engaged in IS facilitation efforts, and in which capacity they may contribute. Following this exercise, a small reflection discussion takes place and the participants are encouraged to replicate similar exercises with relevant stakeholders from their contexts.

Figure 2: Example of a digital whiteboard with ideas created during one of the trainings.

SymbioSite Workshop – Identify and explore symbiotic development opportunities

Image: Freepik.com

This interactive exercise simulates a workshop activity that is commonly used in practice to identify symbiotic development opportunities among participating actors and often delivers good results. This exercise aims to serve two purposes: 1) to generate ideas for new symbiotic development opportunities; 2) to improve participants' capabilities to perform similar workshops in their contexts. The exercise is customized by selecting activities that either exist of can be developed in the context. The participants are given some instructions about one week in advance, and carry out a one hour workshop focusing on the following areas: a) identification of a gross list of synergistic developments that can be applicable to the selected activities; b) detailed discussions on multiple development needs of selected opportunities. Sample outcomes from these different parts of the workshop are presented in Figure 3 and Figure 4.
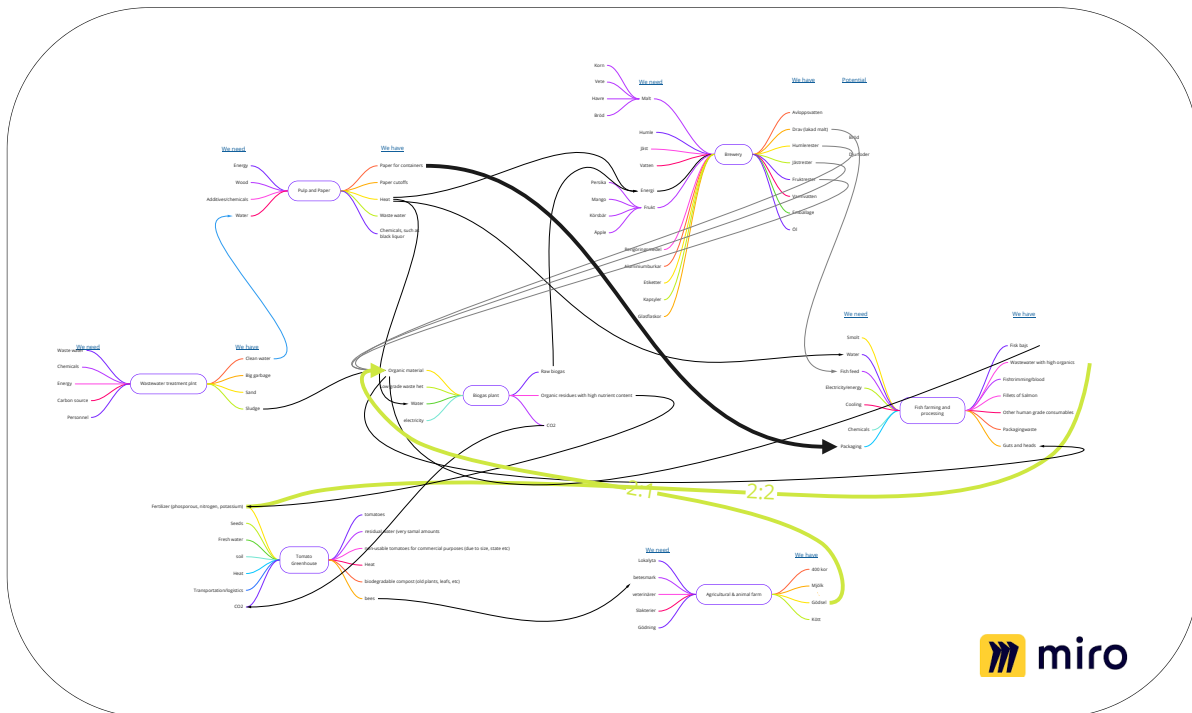
SymbioSite Synergies - Group 2

Figure 3 : Synergistic opportunities identified in the first part of one SymbioSite workshop.

Group 1-3

Drav (lakad malt) från bryggeri till föda fiskodling		
Determinants	**Key challenges/issues**	**Needed actions**
Technical/Operational	• Geografisk närhet/avstånd - transportlösning • torkanläggning • energi för ovan • befintlig teknik för att göra till djurfoder	• stöd av logisitikexpert • kunskapsutbyte med aktörer om tillämpar metoden idag • Ytterligare fastighetslösningar och energibehov - detta i sin tur kanske man kan initiera samarbete med andra lokala industrier
Organisational	• personal för torkning • Tidigare kunskap finns att tillgå • Avtalsregleringar	• Rekrytera personal • Juridisk assistans • Finns fler fiskodlingar eller andra aktörer som kan motta drav?
Economic	• Investera i torkanläggning • potentiella besparingar för fiskodlingen • intäkter för bryggeriet	• Finansieringslösningar i form av bidrag, lån etc • ROI - när ger investeringen avkastning?
Political	• Möjligheter för kommun att påvisa hållbarhetsinitiativ i regionen • Potential för ny sorts finansiering att söka • Krav på avfallshantering i regionen man befinner sig i	• Dialog med kommunen man verkar inom för att få hjälp att kolla lokala regler men coкså undersöka eventuellt utbyte och nytta för kommunen • Kontakt med finansiella institut och projektstödsorganisationer

⫿⫿⫿ miro

Figure 4: Examples of detailed analyses of identified opportunities in the SymbioSite workshop.

2.2   Part 2 – Applied part

To move enhance their contribution to practical work, the PTPs have been designed to have an optional applied part. Here, interested trainees select relevant support/facilitation approaches/tools in dialogue with the trainers, and more importantly with the project partners from the context. They then have 6-8 weeks to work with their selected idea/project either individually or in teams. During their applied work, the trainees have access to support from the trainers and other project partners. Fewer than desired number of participants have chosen to complete the applied part of the training (only 38 out of 86).

The applied part of the training is concluded by an "Experience sharing and reflection" session, where the trainees present and discuss the work they have done in the applied part and received feedback from the trainers and their peers. Participants who joined the main part and choose not to work in the applied part were still invited to the final session, and some did join.

Sample programs of the entire PTPs are given in Appendix 1.

2.3   Engagement and participation

Invitation of participants to the training programs have been a joint effort between LiU and lead partners in different project regions. To attract participants LiU has prepared an invitation letter with key information about the training contents and structure in dialogue with regional partners. LiU has also provided input regarding key stakeholder groups whose participation in trainings would be desirable. After this, the regional partners made a list of stakeholders they would like to invite and reached out to them 6-8 weeks before the training. Interested stakeholders registered for the training using a form, which also collected brief information about their level of knowledge in key

areas. Such input helped confirm, and if necessary adjust, the contents of the training and assisted evaluation assessments.

A total of 86 people actively participated in the PTPs. While the PPTs primarily targeted members from industry, public administration bodies, cluster- and business-organisations, and utility operators, considerable number of representatives from consultancies and research and education institutions also joined the programs. The sectoral breakdown of all participants taking part in different PTPs is shown in Figure 5.
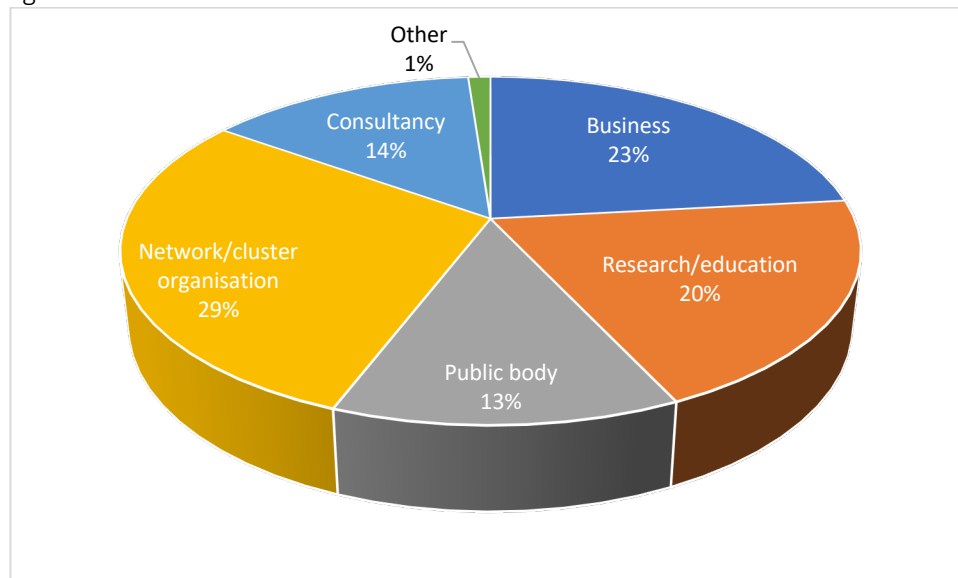

Figure 5: Sectoral breakdown of participants taking part in PTPs.

3 Evaluation and Assessment of the Training Programs

3.1 Evaluation Process

Evaluation of PTPs were performed at different stages and through different means, as summarised below:

Mentimeter survey at the end of main introductory block:
Participants were requested to provide feedback at the end of the main block within the scheduled time of the training. This survey aimed at capturing overall opinions about the main part of the training, as well as opinions with regards to specific training objectives. Here, the participants were also requested to share opinions regarding the elements they found particularly valuable as well as the parts they would like to have improved. Relatedly, both likert scale and open-ended questions were included here. A relatively large number of participants responded to this survey (with 37 out of 86 participants responding).

Mentimeter survey at the end of applied part.
At the end of the "experience sharing and reflection" that concluded the PTP, the participants were asked to respond to another survey. In addition to the specific opinions about the applied part, this survey aimed at capturing participant's opinions regarding the entire training program.

Direct communication with participants and project partners
At the end of the main block, participants were encouraged to share their opinions regarding specific training elements – with particular focus on whether any element could be removed from the training without losing much value and how specific elements could be modified for improved utility. Only 12 of the 86 participants provided feedback – majority shared their satisfaction with the training elements as they were, and only 3 respondents them offered specific improvement ideas. These are compounded by additional input provided by project partners, who had their own reflections and were able to convey reflections they got from their networks.

Last, but certainly not the least, **our direct observations and experiences** from different stages of PTPs are also taken into consideration as part of the evaluations.

3.2 Evaluation Findings

In general, the PTP received very positive feedback in terms of their overall value and impact against intended goals.

3.2.1 Main introductory part of PTPs.

Figure 6 summarises participant responses concerning their agreement with different statements related to generic training objectives (responses are given according to a lickert scale from 1 to 5, where 1 corresponds to "strongly disagree" and 5 corresponds to "strongly agree"). The weighted average of responses indicate that the responding participants found the training valuable, they learned new and useful things, developed new ideas for future work, improved their skills, and even made new connections. It needs to be emphasized that the PTPs were considered effective in enhancing capabilities and social capital in the training contexts.
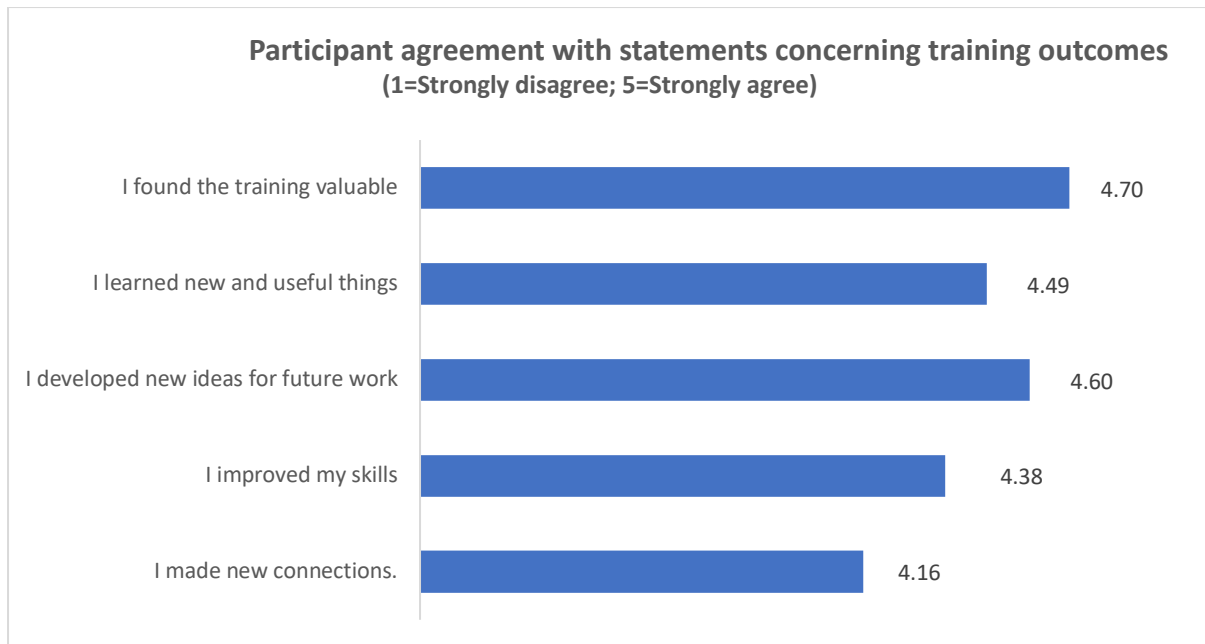
Participant agreement with statements concerning training outcomes
(1=Strongly disagree; 5=Strongly agree)

Statement	Value
I found the training valuable	4.70
I learned new and useful things	4.49
I developed new ideas for future work	4.60
I improved my skills	4.38
I made new connections.	4.16

Figure 6: Weighted overall opinions regarding PTPs overall value.

Regarding specific objectives concerning enhancement of knowledge and understanding in relevant areas, the findings again indicate a significant impact – as supported by the responses summarised in Figure 7. Improved knowledge on the importance and benefits of IS is important because this allows facilitators to more effectively secure commitment from relevant actors in their contexts[5]. Enhancement of knowledge on different IS practices and their impacts is also very valuable as IS can involve diverse resource transactions and partnerships and can produce a diverse range of sustainability impacts. Awareness of such diversity is important for (potential) facilitators as this allows them to seek for, and support, IS opportunities across a wide spectrum (as opposed to only seeking waste valorisation options, for example). Last, but certainly not the least, as the ultimate objective of the training is to enhance "facilitation" related knowledge and competencies, a strong agreement with the positive impact on this dimension is a particularly valuable outcome for the PTPs.

How did the training influence your knowledge and understanding regarding...
[1: Remains unchanged; 5: Greatly improved]

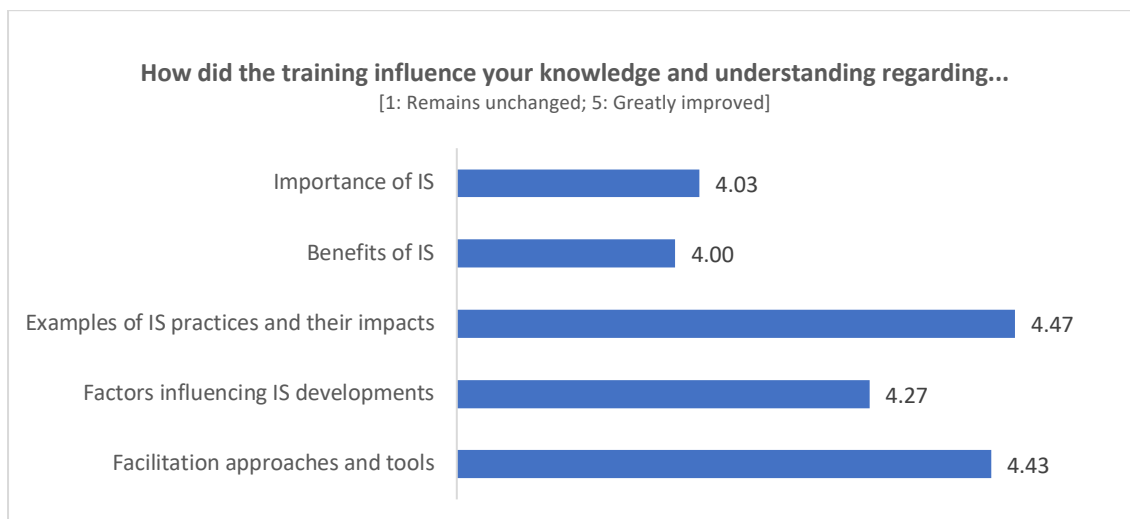| Topic	Value
Importance of IS	4.03
Benefits of IS	4.00
Examples of IS practices and their impacts	4.47
Factors influencing IS developments	4.27
Facilitation approaches and tools	4.43

Figure 7: Weighted average of opinions regarding trainings impact on knowledge/understanding.

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[5] Relatively lower results in the first two categories are likely to be connected to some participants having fairly high levels of background knowledge on the concept – as some of the participants have been working with the concept for some years.

Free statements from respondents provide further details on opinions about the main part of the PTPs. Selected, unedited examples of responses to the question "what elements of the training you found particularly good?" are given below.

PTP location	Example responses	
Denmark	The networking and idea generation with peers from other organizations..	As it is mostly relevant in regards to initiating new symbiosis and facilitating. The informations regarding these aspects were the best
	The involvement of the participants. That it was possibly to try out some f the tools in collaboration with the others	Examples of other industrial symbiosis acorss Scandinavia. Interresting tools that seemse to work :)
Kemi-Tornio	Examples, new ideas for work	Examples are always good to clarify things
	Group discussions, facilitating guidance, a lot of material and good examples	Holistic approach, good materials, exercises
	Real examples and like-real communication and discussions	
Trøndelag	In general, the combination between teoretical input, case-examples and practical work on the miro boards were good. Well sewn together as a "package" over 3 hours.	In general, the combination between teoretical input, case-examples and practical work on the miro boards were good. Well sewn together as a "package" over 3 hours.
	The examples from the realityThe explaining of the complex process of IS and the determinants	Exercises were very helpful to think about interesting facts to implement IS in practice
St. Petersburg	Real examples and like-real communication and discussions	Понравилась очень практическая часть тренинга, когда нужно было проанализировать входящие ресурсы и отходы, которые смогут быть востребованы другими производствами, а также командная работа в миро
	Miro is a good tool for visualiation IS pratcices.We plan to become that area and place when people start talking with each other.	*I liked the very practical part of the training, when it was necessary to analyze the incoming resources and waste that could be demanded by other industries, as well as teamwork in the world*
	Interactive sessions	фасилитация процесса промышленного симбиоза
	Очень практико-ориентированный курс, все понравилось	*Facilitation of IS practices*
	Very practice-oriented course, I liked everything	
Gdansk	Discussions	examples of working IS, practical workshops using miro board

PTP location	Example responses
Värmland	**Get tools** The interactive parts were especially important to me. Those parts made a big difference for me in "starting to think and not just listen". The interactive parts connect the information from the presentation to my own organization's possibilities Group discussions were very inspiring. Great to go through exercises ourselves in order to get better understanding on how to apply them as facilitators. Well planned training + Murat was very knowledgable and great instructor.	**Tool practices** Interaction in Miro with the rest of the team testing tools was very valuable. It is one thing listen and see a picture and a completely different to try by your selfes and in group. Even more practical moments had been good but time is short. How Complex it is with all the determinants The discussions that emerge between participants from very different backgrounds, sometimes sharing similar problems, often providing new and helpful perspectives/solutions.

It is satisfying to see that participants found both the training contents and the activities valuable. Interactive elements seem to be particularly valued. Here it is worth noting that some of the tools introduced due to the necessity to run the programs on-line – e.g. working with Miro boards –proved highly useful. In fact, after gaining experience with such tools during the training, participants started to use these in their own contexts.

3.2.2 Applied part of the programs[6]

Generic feedback regarding the value of the applied part is summarised below (Figure 8). Overall scores from most of the contexts indicate that participants found the applied part of the training valuable. It is worth noting that, context with lower overall scores (Denmark and Finland) are also the ones where the extent of symbiotic practice and facilitation efforts are fairly advanced – as identified as part of the initial assessment study. Even in these contexts individual participants found this part of the training very valuable.

Figure 8: Generic feedback on the applied part of the training.

Feedback regarding the specific contributions of the applied part of the training is summarised Figure 9. As can be seen, for most of the participants the applied part has been instrumental in supporting existing work or initiating new work related to IS. It is equally encouraging that the participants expect to initiate new projects soon thanks to the work they have done in the applied part. Equally important is the fact that this part of the training appears to have supported new collaborations – which is a critical inredient for symbiotic developments.

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[6] None of the participants who joined the training in Poland wanted to work in the applied part. Therefore, the assessment in this section only includes feedback from five of the six training programs delivered.

Figure 9: Feedback regarding specific contributions of the applied part of PTPs[7].

Participants also provided examples of specific ways by which the applied part helped them. Unedited examples of statements provided is given below.

PTP location	Example responses	
🇩🇰	I gained specified and concrete knowledge which can lead me to think in a more systemic view in relations with IS	The idea generation contributed.
	used tools to sketch a symbiosis and investigate possibilities with stakeholder in proposed project	specifically, it led us to develop small steps towards a national network. Which is quite concrete and a huge step to develop and spread IS.
🇫🇮	I learned new things about the business situation in Kemi and found some opportunities about industrial symbiosis.	
🇳🇴	Contacts, experience based advice for diving in to the process, tools and and visualisations. A nice feeling of having at great number of distant colleges.	Visualising projects are always a good learning tool.
		Great training experience together with people from similar positions/roles

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PTP location	Example responses

Благодаря практической части я уже построила нескольких симбиотических цепочек, которые будут продемонстрированы Администрации Псковской области

Thanks to the practical part, I have already built several symbiotic chains that will be demonstrated to the Administration of the Pskov region

В развитии идей по интеграции собственных технологий и решений с проектами других участников Балтийского промышленного симбиоза.

In the development of ideas for the integration of proprietary technologies and solutions with the projects of other participants in the Baltic industrial symbiosis.

возникли новые идеи

New ideas emerged.

помогла интегрировать участников в проектную деятельность по промышленному симбиозу

Helped to integrate participants into project activities on industrial symbiosis.

collaboration and dialogue with partners

Стуктурирование информации и новые знакомства

Structuring information and making new acquaintances

Тренинг для меня стал катализатором для суммирования имеющихся знаний и выхода на новый уровень понимания темы. Большое спасибо Мурату и организаторам!

The training became a catalyst for me to summarize the available knowledge and reach a new level of understanding of the topic.

Visualization of ideas, new ideas

"то позволило мне более аргументированно участвовать в подготовке и обсуждении «Плана развития г.Нарва до 2035 года» в части моей рабочей группы «Нарва - пример зеленой энергетики и зеленой промышленности в Эстонии».

"This allowed me to more reasonably participate in the preparation and discussion of the" Development Plan for Narva until 2035 "in the part of my working group" Narva - an example of green energy and green industry in Estonia. "

Get tools

The interactive parts were especially important to me. Those parts made a big difference for me in "starting to think and not just listen". The interactive parts connect the information from the presentation to my own organization's possibilities

Group discussions were very inspiring. Great to go through exercises ourselves in order to get better understanding on how to apply them as facilitators. Well planned training + Murat was very knowledgable and great instructor.

Tool practices

Interaction in Miro with the rest of the team testing tools was very valuable. It is one thing listen and see a picture and a completely different to try by your selfes and in group. Even more practical moments had been good but time is short.

The details of feedback on the applied parts are particularly important, as these clearly show that PTPs went beyond knowledge provision and effectively supported on-going work and mobilized new initiatives in support of IS programs and practices. It is also important to note the catalyst-effect of the PTPs for further capacity building as participants already used the knowledge and experiences they gained in designing training programs for their own organisations and contexts or have intentions to do so in the near future.

As can be seen from Figure 10, feedback was most conclusively when participants asked at the end of the entire training "whether they would recommend this program to the others". It pleases us to mention that participants did recommend the program to others within the scope of the project and this resulted in increased participation in the trainings organised in Norway, St Petersburg and Sweden. Requests were also received to organise additional training programs beyond BIS project.
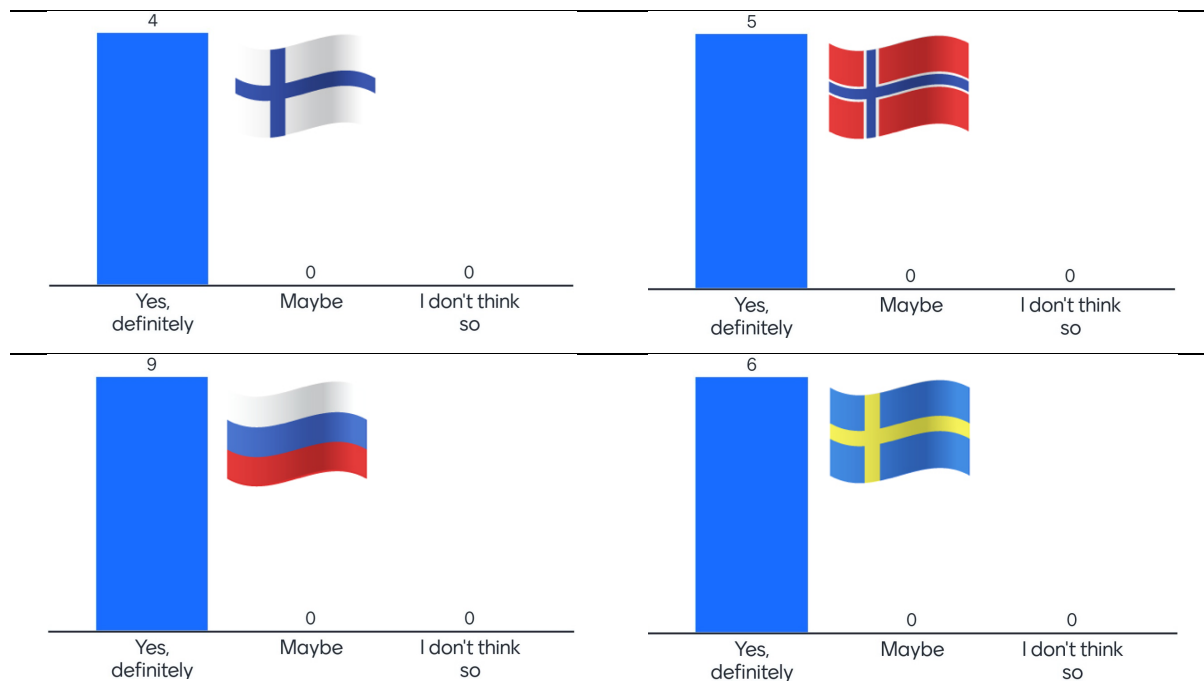
Would you recommend this training to others?

Figure 10: Participant responses regarding whether they would recommend this training to others.

3.3   Improvement potentials

Participants have also shared their ideas for improvements, although much fewer responses were given for this part. Examples of ideas put forward are given below.

PTP location	Example responses	
🇩🇰	Overall I think the teaching sessions worked very well as video conference. The downside is less interaction between paticipents, especially during coffee breaks	Sending material beforehand so that we have more time to digest the material
🇫🇮	More time for discussions	
🇳🇴	More interaction between participators. Roadmap for the first steps - if possible.	
🇷🇺	Just more partnerships with the regions and you will have more real examples	Хотелось бы еще больше практических примеров I would like even more practical examples.
🇸🇪	Hard sitting and looking at a screen all the time, good with breaks. Could even be more breaks and shorten the presentation and add more practical discussion.	It was difficult to stay focused sometimes when there were long sessions with presentations and short breaks, even if there were interesting things presented

Majority of the improvement suggestions relate to practical arrangements of the program, and most is linked to time allocation. Participant feedback endorses the value of interactive parts of the PTPs – where actors get to know each other better and take initial steps towards creating mutual understanding and forming joint conceptualisations and opportunities – and calls for their expansion. As noted earlier, such feedback was taken into consideration and acted upon to the extent possible - following the experiences and feedback from the first training in Denmark, the duration of the main part of the programs increased from 6 to 9 hours, and majority of this additional time was allocated to interactive sessions. With the online interactions, further expansion of the time was considered unfeasible – as keeping participants focused becomes challenging with longer durations. Limited time availability also had implications on other ideas (e.g. LiU was in a position to introduce a higher number of practical examples, but these would have to come at the expense of other important training elements). The original design of the programs would most likely have addressed such problems as more scheduled time would have been available and interactions could have continued during breaks and social activities. It is also likely that face-to-face interactions would have higher quality and utility.

3.3.1   Reflections from training coordinators.

Based on our own improvements, we also would like to put forward the following improvement considerations:

- **Improved diversity:** Involvement of representatives from diverse societal sectors (businesses, public bodies, academia, network organisations and consultants) in the programs were particularly important, as this allowed actors to better understand each others' interest, objectives and challenges. When actors collectively created development ideas (in time fictional) and discussed their facilitation needs, diverse representation was also important as this allowed the participants to better appreciate respective facilitation strengths of different actors and the need for coordinated collective action. Such impacts appeared to remain limited in those programs where sectoral diversity was somehow limited. Therefore, it would be worthwhile to put extra effort to assure sectoral diversity in future programs.
- **Stronger commitment from participants:** Participants came to the programs voluntarily, and not all of them seemed to have the time resources to follow the entire program or to work in the applied part (a situation that was not helped by the extraordinary circumstances induced by the pandemic). This has implications not only for those who cannot offer full commitment but also the others, as the participants are also the resources in the programs. Securing stronger commitment from participants – e.g. through offering officially sanctioned degrees or perhaps requiring symbolic fees – would improve the future programs.
- **Promotion activities:** In some contexts, the knowledge of, and relatedly interest in, industrial symbiosis concept remains highly limited. This causes difficulties in the recruitment processes, in times beyond the influence of regional partners. During this project, we tried to address these through promotion efforts, that proved effective when possible. In cases where such promotion was necessary but not possible (due to pandemic) participation has been negatively affected. Thus, proper promotion efforts should be an integral part of future training initiatives.
- **Local capacity (training the trainers):** The original project plan (according to which LiU was responsible for the development of the PTPs and their delivery in only two project regions – Sweden and Norway) was not possible to follow and part of the reason was inadequate local capacity to deliver the trainings in project contexts (with LiU's involvement in supporting capacity). Relatedly, all programs were delivered by LiU. This had some minor challenges, such as running the programs in a foreign language (although all participants were fluent in English language, it is possible that some interested actors did not join the training due to

language barriers). It is therefore important to build capacity in different contexts so that local actors can be in charge of delivering the programs. To assist this, a "training the trainers" initiative should be considered;

- **Flipped classrooms:** Having to rely more extensively on on-line approaches may enable improvements in the future under the right conditions. One of these will be to use the so-called "flipped classroom" approach. Here, the participants develop basic understanding on key areas prior to collective real-time sessions – such as watching prerecorded presentations or lectures–which can then be used for interactive exercises. Such efforts were partially tested within the project but abandoned due to lack of right circumstances (ie. only few people appeared to come prepared). In future efforts with higher participant commitment, such approaches can be employed and would enable more time for interactive activities.

- **Customised advanced modules:** One of the challenges, applicable to any training, is the fact that individuals have different background knowledge on different subject areas and therefore are impacted differently from the training. As a first comprehensive attempt, the PTPs covered a broad spectrum of areas for baseline capacitation. There is a large potential to offer this kind of "foundation setting" capacitation programs to a wider group. There are, however, other actors who are in need of more in-depth knowledge, and capabilities, on specific areas (such as conducting residual resource qualifications or performing policy screenings) and the number of such actors will increase as the baseline understanding on the concept increases. Relatedly, in the future it would be worthwhile to develop and deliver additional training modules focusing on more specific needs.

- **Increased in-person (on-site) interactions:** A critical ingredient of advancing capacity for industrial symbiosis is the enhancement of communication and relationships among diverse actors that have complementary resources but lack mutual understanding of their common challenges and opportunities. The PTPs we developed have integrated elements that aim to advance both actual communication and relationships and the understanding of their value. While progress towards such ambitions was possible through on-line interactions, a higher-impact would be expected if actors are enabled to interact in person, longer, and being in the same physical environment. Therefore, opportunities for relevant in-person should be maximized to the extent possible in future trainings.

- **Creation of an alumni–network:** Industrial symbiosis developments involve complex and context-specific processes and there is still a sizeable need to improve knowledge and techniques regarding effective facilitation. Both development and diffusion of such knowledge and techniques can be greatly assisted through increased communication and collaboration among actors engaged with IS facilitation in different contexts and with different orientations. Creation of an alumni-network with individuals enrolled in PTPs will enable this. It will also enable sustained advancement of the training programs and actual impact with IS facilitation. Thus, creation of such an alumni network should be an integrated element of future training initiatives.

4   Conclusions

To the best of our knowledge, with its comprehensive needs-based content and its applied nature, the practitioner training developed and delivered within the BIS project was a first of its kind. Due to the limitations imposed by the Covid-19 pandemic, the training programs had to be re-designed and adapted for distance delivery through on-line interactions and tools. Despite the generic difficulties brought by the pandemic and the limitations that are more specific to the "on-line only" approaches, within the scope of the project six PTPs were delivered and, going beyond original ambitions, a total of 86 representatives from key stakeholder groups took active part. The feedback received by the participants, and the observations by the training coordinators and project partners, clearly shows that PTPs fulfilled their objectives by enhancing knowledge and capabilities of key stakeholders and thereby improving their capacities to initiate and support industrial symbiosis practices and programs. Expectedly, PTPs had higher impact in contexts where initial knowledge of, and experiences with, IS work were more limited. Nevertheless, meaningful contributions were made in all contexts and the PTPs significantly increased knowledge on:

- Importance and benefits of IS;
- Examples of different forms of IS practices from different contexts and their impacts;
- Technical and non-technical factors with key influence on IS developments;
- Approaches and tools that can be used for facilitating IS practices and programs.

Going beyond sole knowledge creation, and significantly aided by their applied parts, the PTPs also improved skills and triggered development action – or expected to do so in near future. More specifically, the evaluation clearly shows that the PTPs had a significant impact regarding:

- Improvement of relevant facilitation skills;
- Initiation of new work/projects to support IS developments;
- Planning of new work/projects to support IS;
- Improved networking and collaboration.

IS is gaining increasing interest in the EU level as well in different European nations. Relatedly, there is growing need for capacitating relevant stakeholders for wider and more effective facilitation of IS practices and programs. The programs delivered within BIS will offer a solid foundation to meet such need. It will be very valuable to build on the foundation created within this project and provide further support so that similar PTPs can be offered to a larger number of actors from wider geographies. LiU and other project partners that contributed to the development and delivery of current PTPs will be willing to support such future initiatives. The improvement ideas covered in this report (such as increased diversity of and commitment from participants; improved promotion, training of local trainers, building customized advanced modules, considering the use of flipped classrooms, and increased in-person interactions, and establishment of an alumni-network) highlighted in this report can help improve the utility of such future efforts.

5 Appendix 1 – Example programs of entire IS practitioner training

Program of the PTP for Trøndelag, Norway
Introductory Block

Day 1 - 5 May 2021

09.00: Welcome and introductions

09.20: Need for a resource transition and the role of Industrial Symbiosis (IS), *Murat Mirata*

09.40: Main forms and mechanisms of IS, *Murat Mirata*

10.00: Break

10.10: Operational examples and benefits of IS, *Murat Mirata*

11.00: Break

11.10: Group discussions – what makes or breaks IS?

11.55: Closing of the day

Day 2 - 6 May 2021

09.00: Workshop – Developing a SymbioSite

10.00: Break

10.10: Determinants of IS emergence and developments, *Murat Mirata*

11.05: Break

11.15: Policies and IS – *Thomas Budde Chrisentsen, Roskilde University*

11.45: Dialogue with *Morton Solstad* on the Role of municipalities for IS support.

12.00: Closing of the day

Day 3 - 7 May 2021

09.00: Recap from Day 2

09.05: Group discussions – Influencing IS determinants

09.40 IS facilitation approaches and tools, *Murat Mirata*

10.00: Break

10.10: Dialogue with Håkon Okkenhaug, Advancing IS in Levanger municipality (tbc)

10.30: Performance assessment for and in IS networks, *Roozbeh Feiz, LiU*

11.00: Break

11.10: IS facilitation approaches and tools (contd) *Murat Mirata*

11.40: Introduction to the applied block

11.50: Final discussion and feedback

Applied block

7 May – 14 May: Selection of applied part work/project

14 May– 21 June: Work on the applied part

22 June, 13-17:   Experience sharing, reflection and feedback

Program of the PTP for Värmland, Sweden

Introductory Block

Day 1 – 25 August 2021

09.00:   Welcome and introductions
09.20:   Need for a resource transition and the role of Industrial Symbiosis (IS), *Murat Mirata*
09.40:   Main forms and mechanisms of IS, *Murat Mirata*
10.00:   Break
10.10:   Operational examples and benefits of IS, *Murat Mirata*
11.00:   Break
11.10:   Group discussions – Barriers to and enablers of IS?
11.55:   Closing of the day

Day 2 – 26 August 2021

09.00:   Determinants of IS emergence and development, *Murat Mirata*
10.00:   Break
10.10:   Determinants of IS emergence and development (continued), *Murat Mirata*
10.30:   Workshop – Developing a SymbioSite
11.40:   Dialogue with Per Myhrén, Paper Province – "Living Labs to support IS developments"
**12.00**   Closing of the day

Day 3 – 27 August 2021

09.00:   Group discussion – "Who can and should do what to influence determinants?"
10.00   Break
10.10   IS facilitation approaches and tools, *Murat Mirata*
11.00:   Break
11.10:   Performance assessment for and in IS networks, *Roozbeh Feiz, LiU*
11.30   IS facilitation approaches and tools (contd) *Murat Mirata*
11.45:   Introduction to the applied block
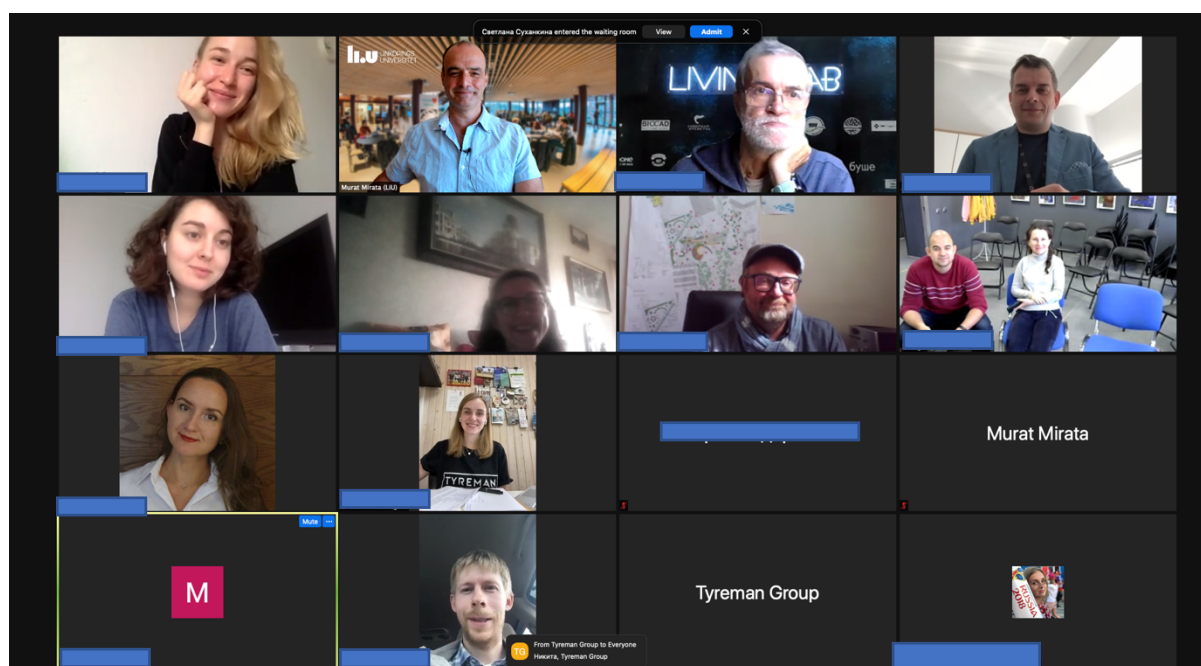**11.55:**   Feedback
12.00:   Closing of the session

Applied block

27 August – 3 September: Selection of applied part work/project
3 September – 8 October: Work on the applied part
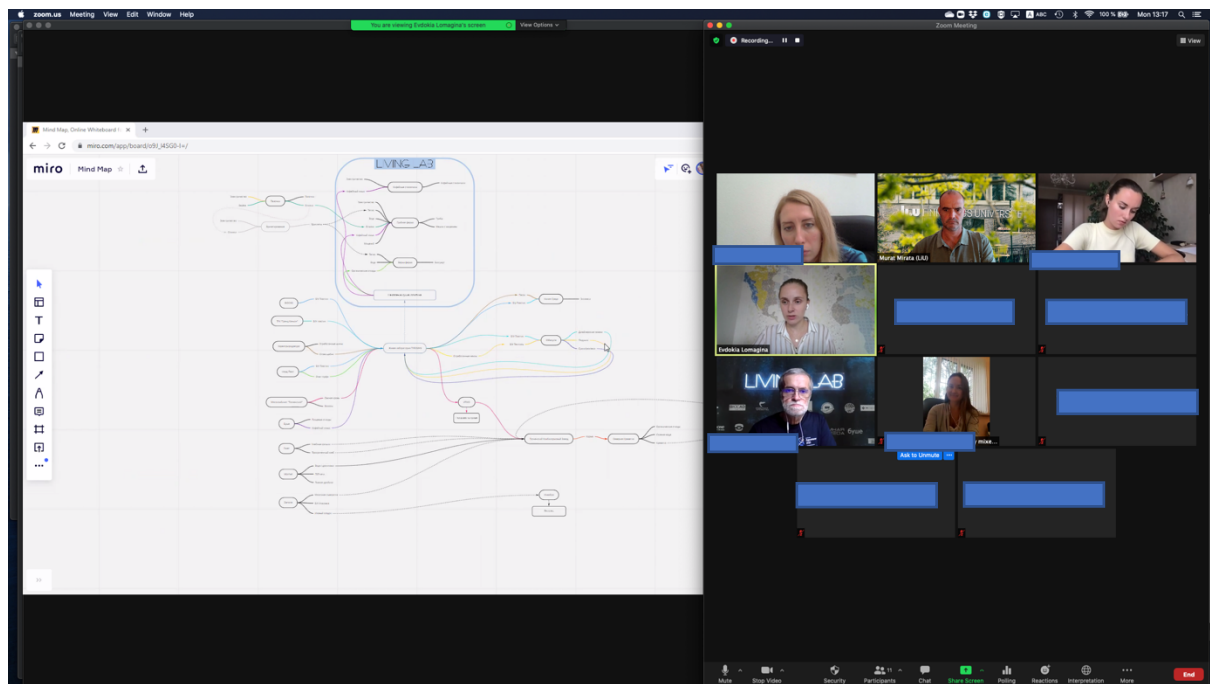12 October, 13-17:   Experience sharing, reflection and feedback

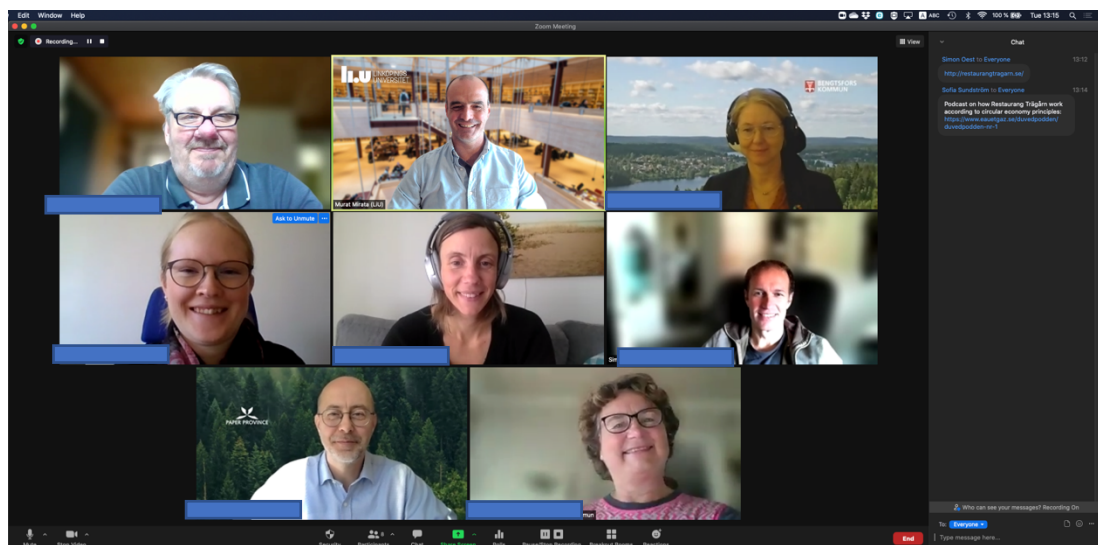# 6 Appendix 2 – Example screenshots from PTPs
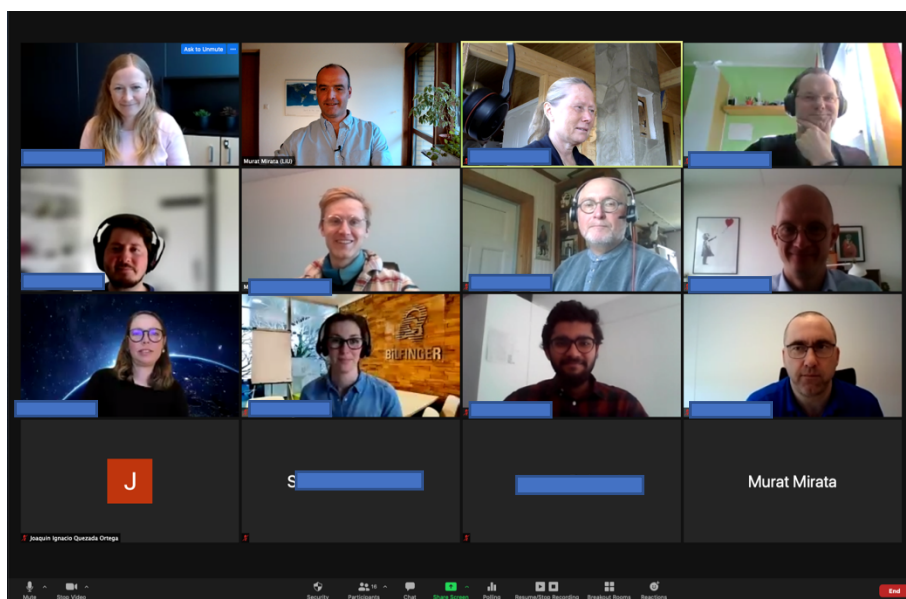
Screenshot from the main part of PTP organised for stakeholders in Trøndelag (6 May 2021)

Screenshot from the main part of PTP organised for stakeholders in St Petersburg (9 June 2021)

Screenshot from the applied part of the PTP organized for stakeholders in St Petersburg (23 August 2021)

Screenshot from the applied part of the PTP organized for stakeholders in Sweden (12 October 2021)