Final report – Innovative Digital Services for Wooden Buildings

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1. Executive summary / Tiivistelmä

As construction industry suffers from low productivity and is one of the least digitized industries, HEAL and its' activities want to impulse a change by starting a multi-disciplinary and cross-industry movement which will at the same time promote wood industry as a fore-runner in new technologies and automation/digitalization. This project was one step in this journey.

During the project, HEAL team tested different digital (demo) tools in a real building project, Eco Pavilion, that was designed and built in Seefeld, during the beginning of the year 2019. The tested demo tools are part of the HEAL's bigger "mission" to make designing and building of timber buildings easier, more efficient and at the same time improve the health of the buildings and their occupiers.

Key outcomes from the work done during the project are following:

- Good visibility of digital demos and HEAL story in industry events and media
- Impulse different stakeholders to collaborate in digitalization of the industry and more specifically to exchange information related to BIM standardization
- Bring sustainability aspects more visible in the construction industry and tech events
- Learn and experiment from service design and agile (scrum) development methods

Both the final digital demos as well as the HEAL bigger vision has been shared widely in different media channels and during different events, both in Finland and other European countries. Feedback has been very positive and many different stakeholders, including other material manufacturers, property developers, construction companies and others are joining in the development to make healthy living more affordable through better collaboration, transparency and finally improved efficiency.

There were many important learnings from this project. During the project we realized that the building value chain transformation is an enormous challenge and can only be done bit by bit. It is better to concentrate more on the design and build phase than try to cover the whole lifecycle. Instead of normal project management practices, digital tools are developed with agile methods which require totally new skills and resources. Especially the agile and intensive two weeks' development sprints need a proper product owner who give the developers not only the tasks but also know how to prioritize tasks. Another learning is to have very clear use cases that are defined together with the potential users. It is very important to involve them to the discussions and planning from the beginning.

New ideas and projects were born during the project, some of which have been already kicked-off. BIM standardization for example is a topic that needs wide industry collaboration and HEAL has been working as a catalysator to bring different parties together, both from industry and technology side. New ideas of the use of AR/VR technology in our industry also came out, such as applying AR/VR for training of timber element installation especially for newcomers, or adding new "dimensions", such as audio to VR to improve the user experience.

Rakennusteollisuus kärsii alhaisesta tuottavuudesta ja digitalisoinnin vähäisestä hyödyntämisestä. HEALin (Healthy Affordable Living) tavoitteena on laittaa muutos liikkeelle fasilitoimalla eri alojen ja ammattiryhmien yhteistyötä sekä samanaikaisesti markkinoida puutuoteteollisuuden asemaa edelläkävijänä uusien teknologioiden, automaation ja digitalisoinnin käytössä rakentamisessa. Tämä projekti on yksi askel tällä HEALin “matkalla”.

Projektin aikana testattiin erilaisia digitaalisia demotyökaluja oikeassa rakennusprojektissa, Eko-paviljongissa, joka suunniteltiin ja rakennettiin Seefeldiin vuoden 2019 alkupuolella. Testatut demot ovat yhtenä osana HEALin missiota, joka on tehdä puurakennusten suunnittelusta ja rakentamisesta helpompaa ja tehokkaampaa samalla kun laatu paranee, jotta rakennukset kestäisivät kauemmin ja olisivat terveellisempiä niiden käyttäjille.

Projektin tärkeimmät tulokset ovat:

- Digitaalisten demotyökalujen ja HEALin hyvä näkyvyys teollisuuden tapahtumissa ja mediassa
- Eri sidosryhmien yhteistyön lisääminen teollisuuden digitalisoinnissa, erityisesti informaation ja kokemusten vaihtaminen BIM standardisointiin liittyen
- Kestävän kehityksen näkökulman tuominen keskusteluihin rakennusteollisuuden ja teknologiatapahtumien agendalle
- Oppi ja kokemus palvelumuotoilun ja agiilin (scrum) projektijohtamisen metodeista

Sekä tulokset digitaalisista demotyökaluista että HEALin isompi visio on jaettu monien eri viestintä-kanavien kautta ja Suomessa sekä muualla Euroopassa pidetyissä tapahtumissa. Palaute on ollut erittäin positiivista ja monien eri sidosryhmien edustajat, mukaanlukien muiden rakennusmateriaalien valmistajat, grynderit, rakennusliikkeet ja muut tahot ovat liittyneet mukaan kehittämään terveellisem-pää ja edullisempaa asumista. Siinä onnistuminen vaatii parempaa yhteistyötä ja läpinäkyvyyttä eri tahojen kesken, joka lopulta parantaa myös tehokkuutta.

Projekti opetti tiimille monenlaisia asioita. Rakentamisen arvoketjun muuttaminen on todella valtava haaste ja muutos voi siten tapahtua ainoastaan pienin askelin. Ei kannata yrittää muuttaa arvoketjun kaikkia osia samaan aikaan, vaan keskittyä ensin tiettyyn osaan. HEAL päätti keskittyä ensin suunnittelun ja rakentamisen haasteisiin. Perinteinen projektijohtaminen ei toimi digitaalisten työkalujen suunnittelussa, joten tässä projektissa käytettiin agiilin projektijohtamisen menetelmiä, erityisesti Scrumia. Tämä vaatii täysin erilaista osaamista ja resursseja. Agiilien projektien, sprinttien, koordinoimiseen tarvitaan tuoteomistaja (product owner) joka tietää mitä digitaalisten työkalujen kehittäminen on, osaa antaa koodaajille tehtäväkuvaukset ja priorisoida eri tehtävät oikein.
Jotta kehitystiimillä on järkevää tekemistä, tarvitsee ensin määritellä, mielummin yhdessä tulevien käyttäjien kanssa, työkalun tarkka tehtävä (use case). Potentiaalisten käyttäjien mukaanottaminen ja kuunteleminen heti alussa on todella tärkeää jos halutaan saada onnistunut demo aikaiseksi.

Projektin aikana syntyi useita uusia ideoita ja projektiaihioita. Osa ideoista on jo laitettu eteenpäin. Esimerkiksi BIM standardisointi on niin iso aihealue, että se tarvitsee teollisuuden yhteistyötä johon HEAL on voinut vaikuttaa “katalysaattorin” tavoin tuomalla eri tahoja yhteen, sekä teollisuuden että teknologian taholta. Projektissa tuli myös uusia ideoita liittyen AR/VR teknologiaan, esimerkiksi sen käyttäminen uusien toimijoiden opetuksessa puuelementtien asennukseen, tai uusien “dimensioiden”, kuten äänimaailman, lisäämisessä käyttäjäkokemukseen AR/VR projektissa.

2. Background

The building industry is lacking behind in terms of productivity and digitalization, compared to most of the other industries. On the other hand, wood construction has already long been highly automated. Its' great disadvantage is that the industry is highly fragmented and therefore it lacks norms and standards, especially when it comes to Building Information Management/Model (BIM). Owners of buildings would be the main beneficiaries of a move to a more productive model that will eventually reward them with higher schedule reliability, higher quality and lower costs.

Another challenge today is, that 84 million Europeans (every 6th European) live in damp or mouldy dwellings, increasing their risk of developing respiratory diseases and life-long allergies. The condition of the homes that we live in has a direct impact on how healthy we feel. An awareness of the state of housing in our cities and suburbs is vital if we are to achieve healthy and sustainable societies.

Established by Stora Enso and Trä Group, HEAL is an open innovation platform with the aim to shape a future of healthy affordable living. Together with partners, the purpose of HEAL is to co-create how buildings are designed, built and maintained, to enable healthy and sustainable living for all.

By leveraging tech-driven projects, HEAL advocates for trust and transparency throughout the entire building value chain. Transparency means for example that the delivery of building material can be followed in real time and online through effective tracking from source to building site. In addition, transparency in material information is pursued by developing Building Information Models (BIM) that provide details on used materials. Transparency also means having available IoT data to assure simple ways to follow and control issues related to a healthy living environment, such as moisture and indoor air quality.

The first Kasvua ja Kehitystä Puusta -program by the Ministry of Environment was launched in the autumn of 2018 when HEAL had been piloting its' first Proof of Concepts. "Puurakentamisen digitalisaation edistäminen" (Promoting the Digitalization of Wood Construction) was exactly what HEAL was for, and as the Seefeld Ski Championships also gave the opportunity to test different concepts in a real building, Stora Enso together with TRÄ Group applied for a fund to test different digital concepts and technologies in the Eco Pavilion and share the feedback and learning with a wider public.

3. Objectives

The long term "vision" of HEAL is to develop both the economic and technical advantage for the wood construction industry in comparison to the concrete or steel industry. This will happen by automating and digitalizing the whole process from planning, through manufacturing and building, and facility mgt. Some key elements of this transformation are open BIM, augmented and virtual reality as well as data collection by using sensor and IoT technologies.

In this process the whole ecosystem is invited to participate to develop a common platform and tools that benefit different stakeholders. By making the process "leaner", fact based (through enriched data)

and more efficient, both building owners and planners can make their building material related decisions much faster and with lower risk.

The project Innovative Digital Services for Wooden Buildings (later InDiSe) had three main objectives:

1. Increasing the knowledge on wood materials, their properties and use, among the international construction players, including decision makers, professionals as well as the consumers.
2. Assuring the previously mentioned stakeholders, that wood as construction material is competitive and has many advantages in different phases of building and living.
3. Demonstrating and visualizing the benefits of the latest AR/VR technology and Building Information Modelling

4. Partners

This project has two main partners, Stora Enso Wood Products and TRÄ Group, both having their offices in Helsinki. Stora Enso employees have mainly worked on the planning of the project, especially bringing their industry knowledge for creating the project content and in planning and executing the communication of the results. TRÄ Group members (and especially the TRÄ Digital team) have mostly worked on the development of the technical solution but also planning of the workshops and events and bringing their expertise on service design methods (incl. user survey and feedback).

Other partners that have been participating in the project are following (in no special order):

- Digitalist (part of Grow Group):
    - Support in technical concept (digital platform)
    - Support in communication planning and strategy
    - Support in visual image of HEAL toolbox (brand)

- David Blomquist (digital consultant for Stora Enso)
    - Support in planning, execution and communication of Proof of Concepts

- TBW (The Better Way) and ODE (Office for Digital Engineering)
    - Consulting, training and workshop facilitation of BIM

- Providers of materials and services:
    - Alfred Baumgartner: materials for Seefeld exhibition and workshop
    - PH Solutions: equipment (digital pads) for the events
    - Teemu Andreas: Graphic design for AR solution
    - Dajoha Design: Photos and video materials

- Technology providers that have been involved in the concept discussions:
    - IISY (indoor air quality service provider)
    - Polku Innovations
    - Yepzon

- Collaborators and “testers” of concepts:
  - ZMP (distributor of CLT elements in Austria)
  - Woodcon/Woodplan (Stora Enso partner in Austria/Norway)
  - Woodeum (Property developer in France)
  - SWAP Architekten (architectural office in Vienna)
  - B&K Structures (wood construction in the UK)
  - Many more Stora Enso customers

5. Methods

In this project two key methods have been used, which will be described in following chapters. In addition to these, we have been following the Springboard process defined in HEAL, as it gives clarity on different PoC projects both to the program and steering team. The Springboard process is described in the following picture. There are several toll gates for the steering team to prioritize on-going activities and projects. The steering team consists of members of both TRÄ Group and Stora Enso.

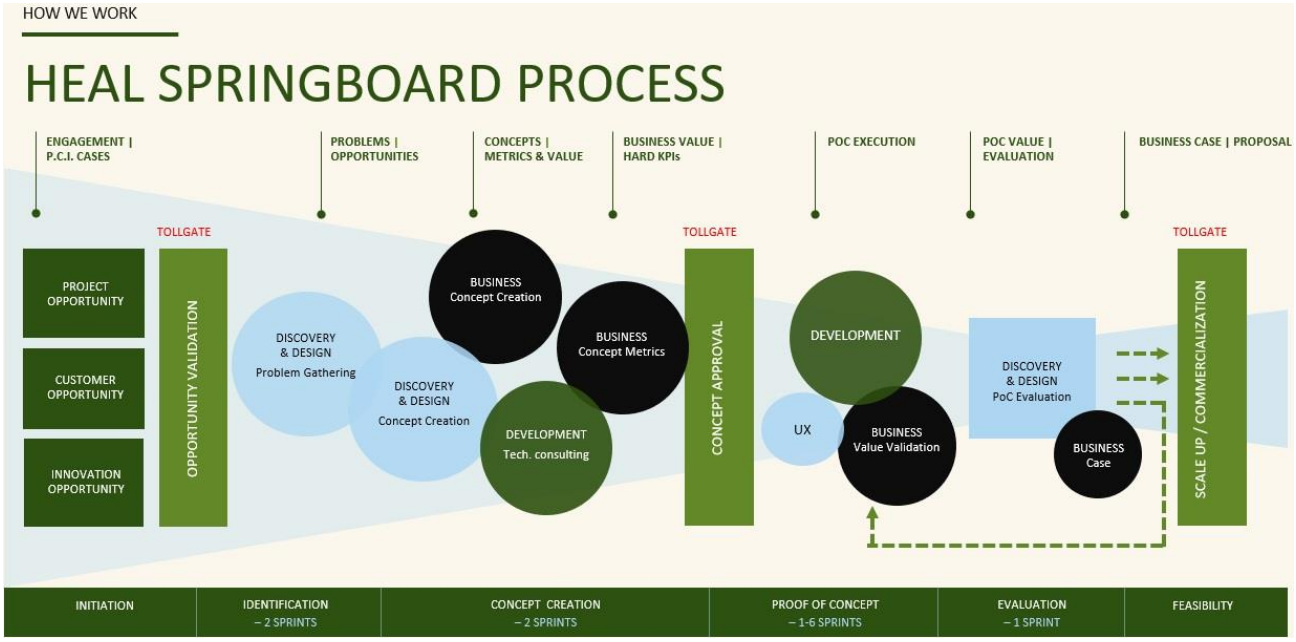

Figure 1: HEAL Springboard process.

The basic idea of joining forces between a corporate (Stora Enso) and a growth company (TRÄ Group) was to have a good combination of agile development, offering speed to execution of projects, but on the other hand use a structured approach and have access to global sales network through Stora Enso. This approach has been working well, but in the beginning it was also challenging, as the “way of working” was very different in the two companies. Both concepts defined in the next chapters, Service Design and Scrum, were used mainly in Stora Enso’s IT and Digitalization teams, but they were very new in Wood Products division. Now, they have been brought to a wider audience and several teams have started to apply them in their own projects.

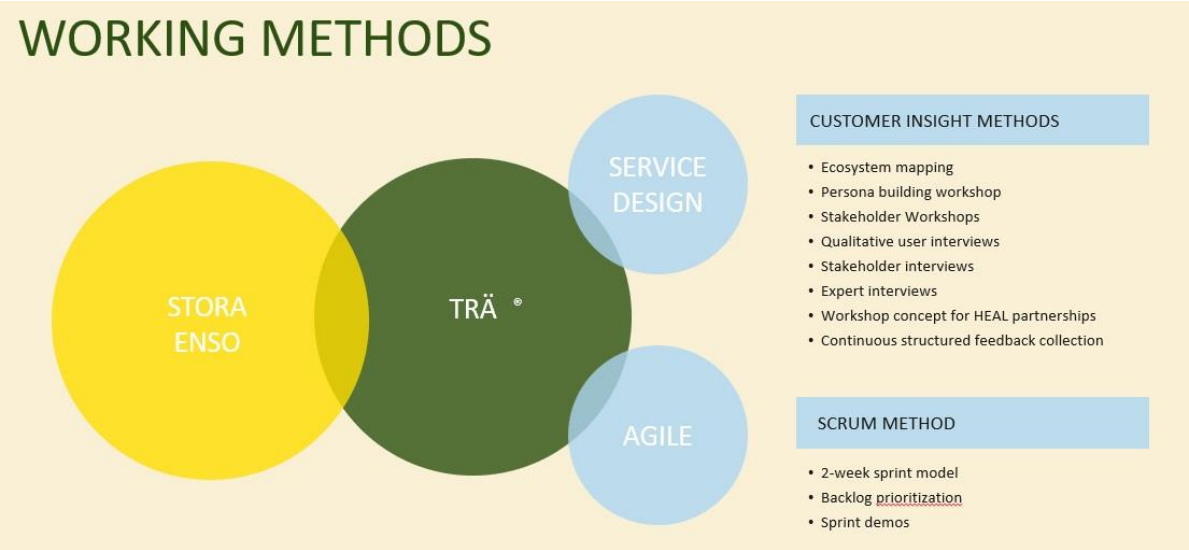

Figure 2: Working methods at HEAL.

5.1 Service Design methods

Service design methods were used during this project, as applied in HEAL projects in general. Normally the process starts by defining the challenges or so called “pains” of a specific user group either by interviewing previously selected users or facilitating a workshop. HEAL defined different workshop “concepts” depending on the desired outcome. The most used workshop concept (in the next figure) is the opportunity exploration workshop, which was also used during this project. As a result of these workshops, project proposals were described, and partners chosen for the project.

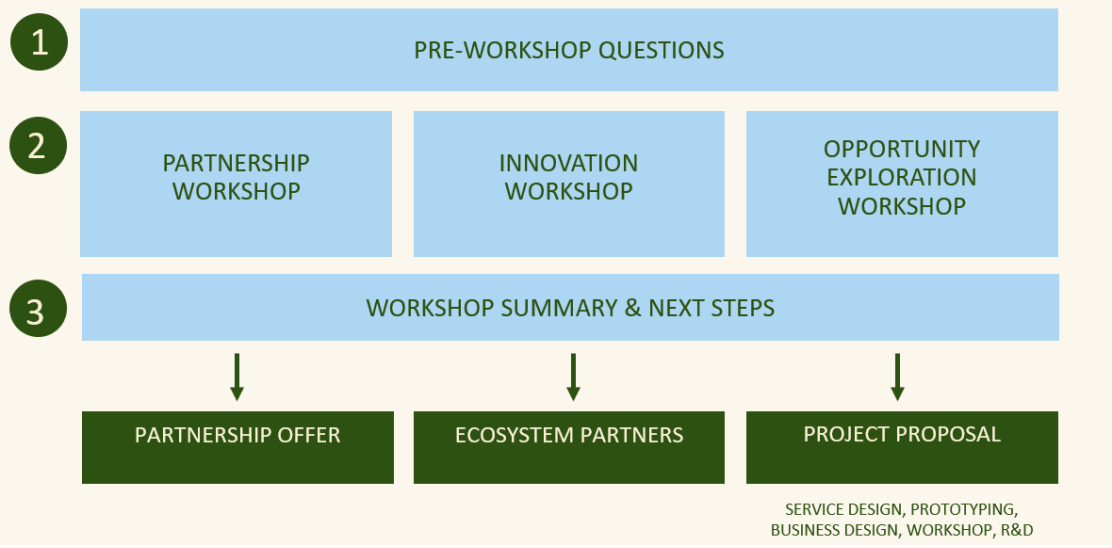

Figure 3: Different workshop concepts by HEAL.

HEAL is organized between three key teams: Business, Discovery and Development. Discovery team is the one, which is responsible for service design. At TRÄ Group, there are two service designers, Jutta and Simone, who have been carrying most of the service design work, supported by Julia from Stora Enso who was responsible for initial contacts with partners/users and initiated the discussions.

Discovery team was also planning the user surveys and testing of Proof of Concepts, e.g. preparing the questions and analysing the feedback. This team also shared the conclusions with the wider team and different stakeholders and was responsible for delivering the content to the marketing team for the communication of results. The discovery team used Miro (a visual collaboration platform) for visualizing the customer journey, pain points and many other different insights. See an example from a discussion with a property developer in the next figure.

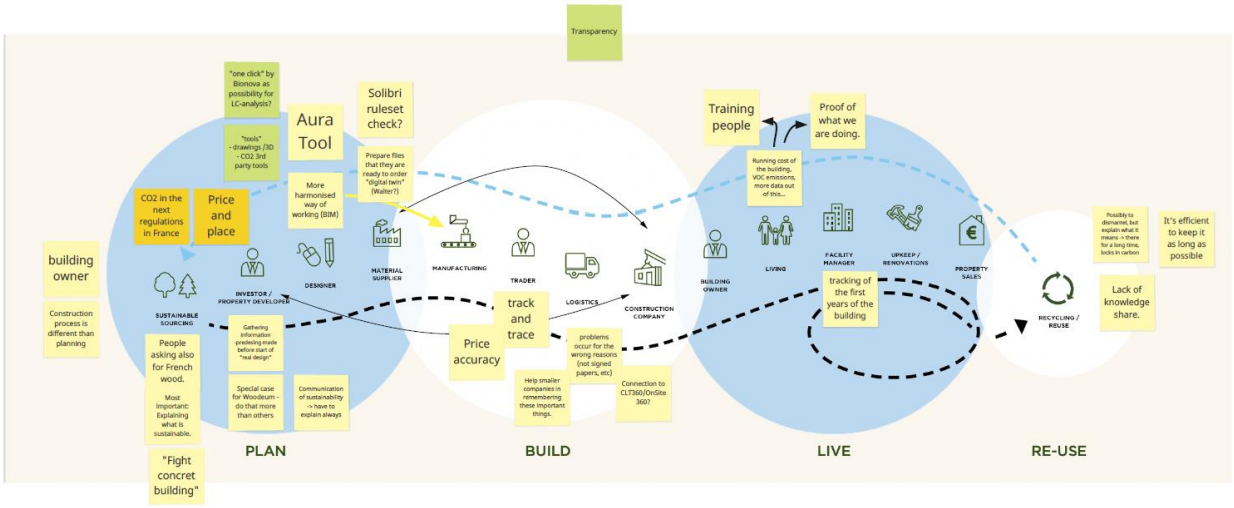

Figure 4: Customer Journey example using Miro.

5.2 Scrum methodology (agile project management)

Another method that was used in the project is the Scrum method, for carrying out the Proof of Concepts by the Development team. The following is a description of Scrum according to Wikipedia:

"Scrum is an agile process framework for managing complex knowledge work, with an initial emphasis on software development, although it has been used in other fields and is slowly starting to be explored for other complex work, research and advanced technologies." (Also see illustration on the right)

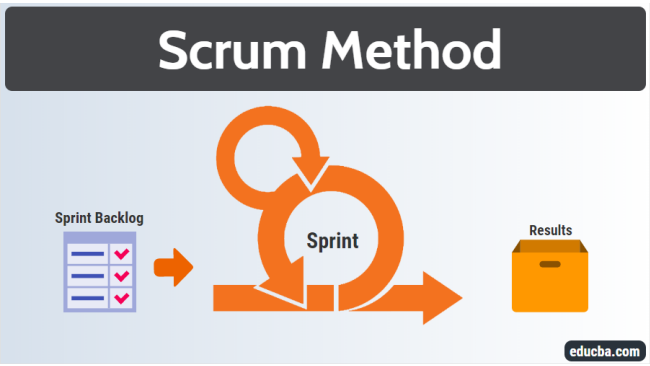

Figure 5: Scrum method in a nut shell.

In this project (and in general in the HEAL team) the sprints started with a sprint planning session on Monday, every second week, and they had the following items on the agenda:

- Discuss and agree on the scope of work that is intended to be done during that sprint
- Select product backlog items that can be completed in one sprint
- Prepare a sprint backlog that includes the work needed to complete the selected product backlog items
- Agree on the sprint goal, and a short description of what should be delivered at the end of the sprint.

In scrum, each sprint lasts for 2 weeks, and each day during the sprint, team members hold a 15 min daily scrum during which developers (sprint team members) need to answer the following questions:

- What did I complete yesterday that contributed to the team achieving our sprint goal?
- What do I plan to complete today to contribute to the team achieving our sprint goal?
- Do I see any problems that could prevent me or the team from meeting our sprint goal?

Finally, after two weeks the results of the sprint are demonstrated in Sprint Demo Sessions, every 2nd week (sprint review). Both TRÄ Group and Stora Enso Wood Products people were invited to participate in these demo sessions and mingled with colleagues, while enjoying drinks and snacks.

Figure 6: HEAL Friday Sprint Demo Session with public.

As one tool for Scrum, HEAL also used user stories to define the task for the development team. The purpose of a user story is to write down how a project will deliver value to the user. It is then the development team's job to take care of how to develop the code that will satisfy the requirements of the user story. A user story often follows the same format. The three components of a user story are:

1. Who- This is typically a job role, customer or type of user, also known as the user persona.
2. What- This is the goal that the user wants the product to accomplish or implement.
3. Why- This is the reason why the user needs the feature or functionality.

An Agile user story is meant to be short, usually fitting on a sticky note or note card. The user stories should be written by the business in the language of the customer so that it is clear to both the business and the development team what the customer wants and why they want it.

6. Project results

The project results are described in this chapter divided into three “sub-chapters”. The first one will explain about the Seefeld case including the demos that were planned and executed there. The second chapter is about the testing and validation of results after the event, and planning for the next steps. The last chapter is dedicated to the communication of the results.

6.1 Results from Seefeld demo planning and execution

6.1.1 Planning of the demos

The Seefeld Eco-Pavilion gave the HEAL team (and Stora Enso as well) a great opportunity to plan a few clear demo cases to be tested in a real building project and having a lot of people visiting the building, testing the demos and giving feedback. As all our projects are based on Scrum methodology, we used the following user stories to describe whom, what and why the demos were made.

User Story 1:

“As **an architect** I want to learn to design timber buildings, but I do not want to take big risks in a real building project. I’d like to **experience and simulate the design and build process virtually** first, but in a way that I can use the data from my own project and “play” with it and learn how to optimize my design. I could show the “virtual twin” of my design to my customer and it would be much easier also for her/him to get a feeling about the design (e.g. dimensions) and **get him/her involved in the design process.**”

User Story 2:

“Me as **an occupant** of a building want to have peace of mind when it comes to the quality of the indoor air and other aspects that might **affect my health**. It would be nice to **have a simple “traffic light” system for monitoring** those issues (e.g. Temperature and humidity of the air, CO2, VOC, …) and getting **pre-warnings** if something is going wrong. I would also like the system to tell me what to do, if something is going wrong and even better, if that process would be automated, so that I would not need to be preoccupied about anything.”

User Story 3:

"**As a carpenter** (or project manager at the building site) I would like to get **accurate, real-time information about the delivery of the timber elements** that are expected to arrive on my building site. I would like to get a message when the goods have left the factory and another one when they are nearly arriving. This would **save me time and money**, as I could use my team and crane efficiently only when they are really needed."

After having the user stories clearly defined, developers (together with the project team) defined more specific use cases (epics) to be able to work on the demo development. Those were also defining the features that were required to get the demo successfully delivered.

In addition to these user stories and features, HEAL also wanted to create additional "tools" that would promote wood construction for the general public in the Eco Pavilion. As HEAL was the main partner for Stora Enso to showcase the story of "sustainable wood construction", it took a driving role in planning and executing simple but effective digital tools for promoting wood construction to "consumers". During the Seefeld ski event HEAL also facilitated a customer workshop to understand better the customer pain points and collect ideas for the next HEAL projects. The following picture shows how the Eco Pavilion building was planned to showcase activities and demos for different user groups.

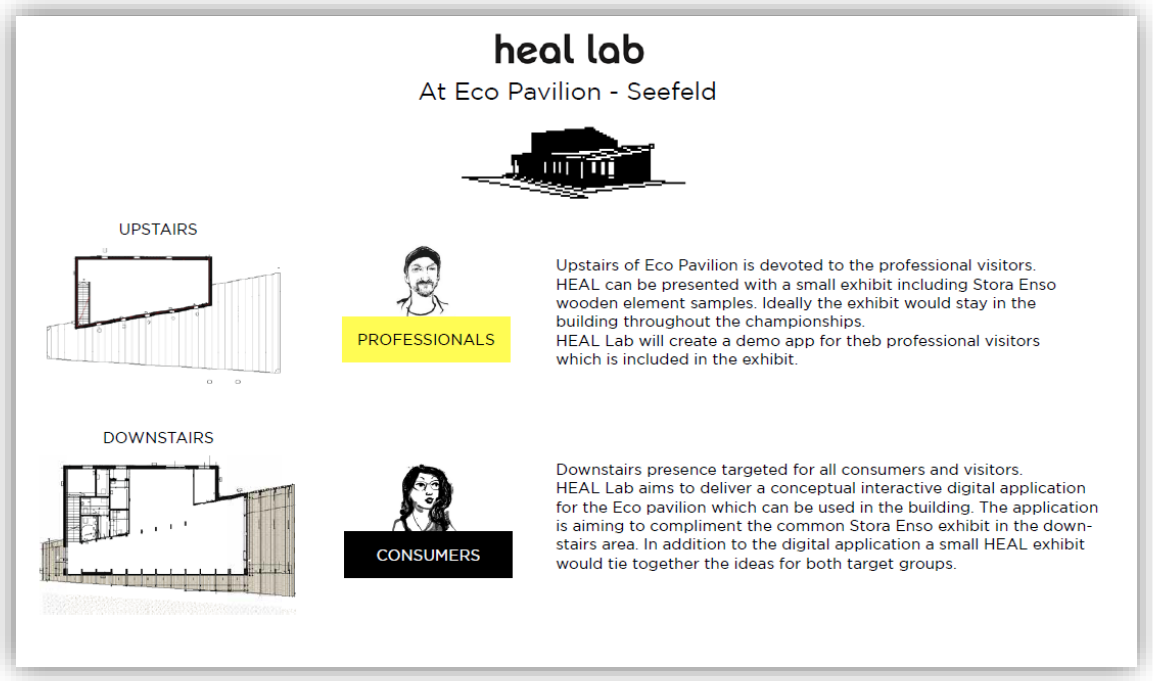

Figure 7: Plan of HEAL activities at Eco Pavilion in Seefeld.

Upstairs was reserved for Stora Enso stakeholders, especially customers and special VIP guests. There, those visitors were guided through a VR experience, both in the Seefeld and Woodcity buildings.

The Woodcity VR experience was developed earlier by HEAL developers and it contains a multitude of useful features to learn about wooden buildings. The upstairs area also worked as a meeting space, and our HEAL workshop was arranged there.

Downstairs was the general exhibition area for all visitors, including the Seefeld ski event visitors (consumers). All Stora Enso products were exhibited downstairs. HEAL prepared two different digital tools for visitors to give a more interactive user experience. Those tools were:

AR Application on the story of Eco Pavilion

- The objective was to show in a fun way, using new technology how the wood has been harvested, manufactured and delivered to the building site and installed into the Eco Pavilion

360 Viewer on the aspects of health and sustainability at Eco Pavilion

- The objective was to give the visitor a futuristic vision about what sensors and new technologies could tell us about our surroundings, especially related to health and sustainability

6.1.2 Final demos (what was done)

Finally, the plans were put into action and both the discovery and development teams had quite a busy few months in planning and executing the planned activities and demos to get them finished by the 20th of February, when the event started. Here are explanations, pictures and graphs about those activities and demos which were finally exposed in the event between the 20th of February and the 3rd of March.

Healthy Living App and microbe analysis

To get a more holistic view of the health aspects of a wooden building, it was decided that there would be some monitoring/sensoring done both inside and outside of the Pavilion. As there were a few start-up companies who offer air quality monitoring and analytics, the first step was to meet with those companies and get their proposals for the Seefeld case. Discussions with IISY and 720 Degrees from Finland and Breeze from Germany were held and proposals analysed, but finally the HEAL team decided not to take an external vendor for this case, because of

- Time limit - preparations would have required extra work and caused extra costs
- Short monitoring period - for more reliable results, a longer time for the data collection would have been needed
- Data ownership - some companies were not willing to share the raw data
- Sensor type - some companies would have preferred to install their own sensors
- Cost-benefit - costs were considered as too high for the case

As no external vendor was chosen, the healthy living app was done internally at Stora Enso by using previous experience from other divisions and projects. The data was collected with active air quality sensors, stored in the Azure cloud and it was shown in real-time in an online portal designed for the occasion. The following sensor types and connections were used:

- Active indoor air quality sensors
  - We used LoRaWAN® indoor environmental sensor MCF-LW12CO2
  - This device reads temperature, humidity, pressure, light intensity, air quality and CO2 and sends collected data over the LoRaWAN® network

- Passive RFID moisture tags:
  - We also used wireless battery-free moisture sensors in form of tags to measure moisture content in the space between the structure and exterior cladding
  - These sensors are very cheap and maintenance free but they need to be read manually with a reader, so they need to be installed in accessible places.

In this pilot the data was shown in graphs, and with a “traffic light colours” to make it easy and quick to see if the air quality was good (green), regular (yellow) or bad (red), as can be seen in following picture.

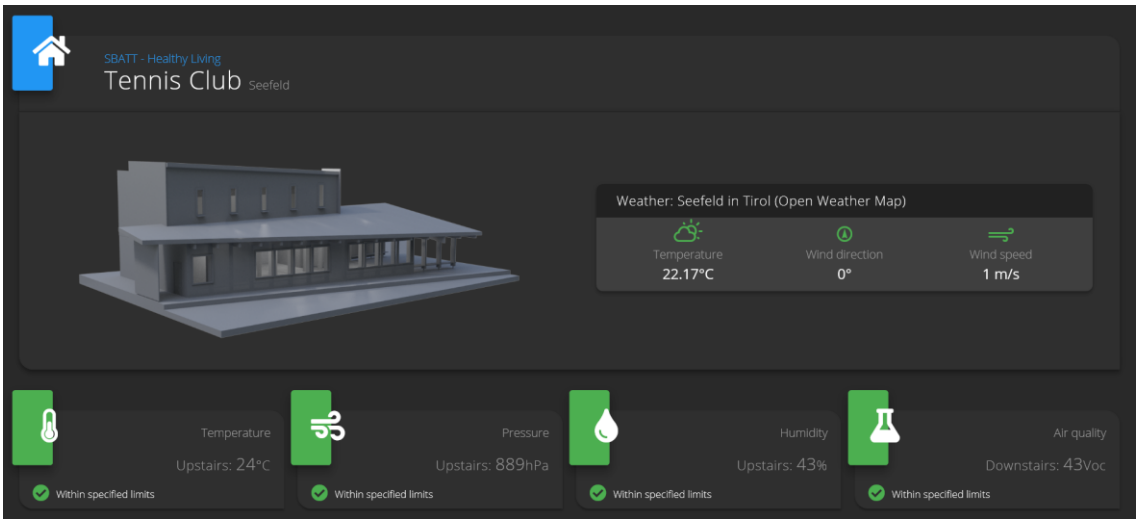

Figure 8: Healthy Living App for monitoring the indoor air quality.

In addition to this digital app (about indoor air quality), the team wanted to get more data from the wooden building, which does not have any moisture damage. The aim of the microbe analysis was to determine the amount of moulds, bacteria and yeasts in the building’s indoor air and to identify them.

In total 28 microbe collectors were installed in the Eco Pavilion a day before the games started. The collectors were simple Petri dishes with filter paper (Nuclepore® Polycarbonate membrane). In the last day of the championships the filter papers were carefully collected from the dishes and stored in sample tubes, which were brought to the Stora Enso Research Centre in Imatra for further analysis.

The Microbiology Laboratory at Stora Enso Research Center Imatra is using DNA-based methods for analysing microbial effects in different processes. Key technologies that they use are:

- Quantitative Polymerase Chain Reaction -method (qPCR):
  - This automated DNA-method provides a large amount of data within days and makes it possible to detect microbial DNA and calculate the number of organisms in a sample
  - In the Seefeld case we analyzed the samples by qPCR (quantitative total amount of bacteria and fungi) and selected positive samples for sequencing
- Next Generation Sequencing (NGS):
  - This technology allows the microbial population to be identified from the sample
  - NGS provides big data that can be used to observe more significant phenomena of microbial changes
  - We utilized NGS sequencing (ITS and 18s) to identify organisms from the samples

Figure 9: Installing the microbe collectors.

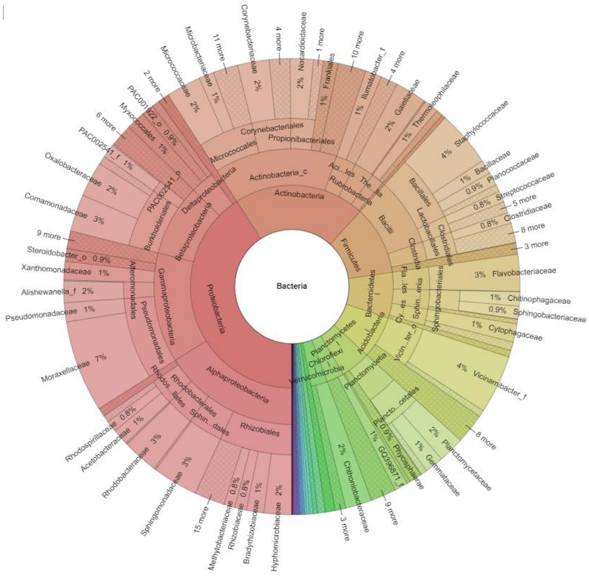

Figure 10: Results from bacteria analysis using qPCR.

Track and Trace App and Story of the Eco Pavilion

Another demo/pilot in Eco-Pavilion was to test track & trace technology including temperature and moisture monitoring during the delivery phase. CLT and LVL elements were tracked with sensors throughout their delivery from the mill until the building site at Seefeld. This type of service (if further developed) would help project managers to get a more transparent view on their deliveries and get related documents online, everything from one source. The following picture shows the generic “architecture” and how the data is collected with active trackers into Azure cloud.

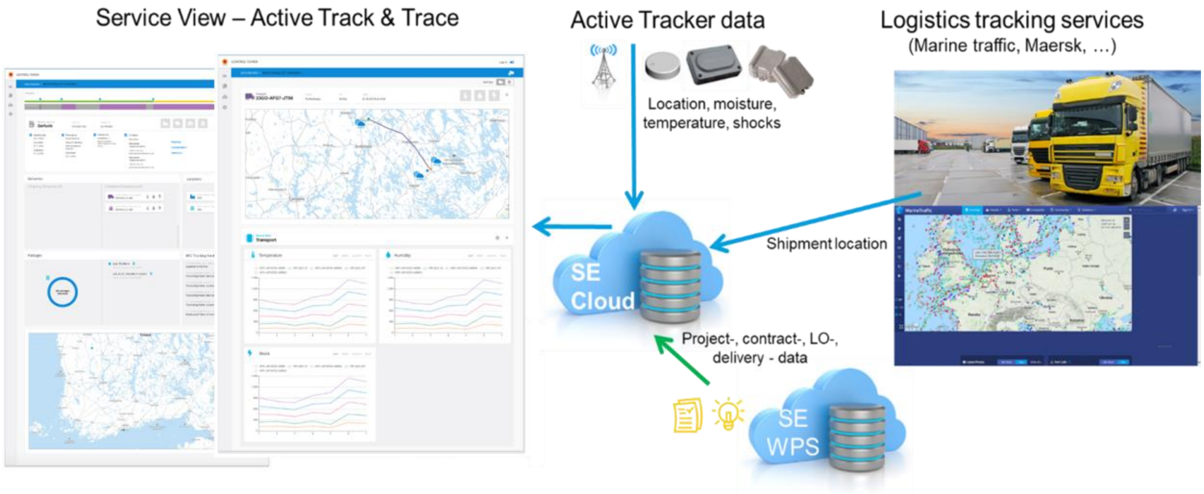

Figure 11: Description of track and trace "architecture".

- Delivery tracking:
  - The 2G/3G/4G/5G trackers with GPS technology (Yepzon) was used for the tracking of goods, because these trackers can send data without a mobile phone or gateway, so it is very easy to handle.
  - No need to install any applications. The tracker just needs power and is ready to go.
  - The tracker provides location and sensor data continuously without any human action
  - Devices are relatively expensive, but they are rechargeable and reusable
- Monitoring outdoor conditions:
  - The same trackers also provide information on temperature, humidity and shocks (maximum acceleration with timestamps) during the delivery process, which is useful especially if the goods are also stored in different places

Figure 12: Pictures of the track and trace sensor installed at CLT panel and a track and trace online portal view.

In addition to the track and trace application that is targeted towards project managers especially (for professional use), the more “fun” app was developed for the public, especially for the smaller visitors. This AR application that tells the visitors the story of the Eco Pavilion from forest to its’ final form is an interactive way to show people how CLT elements come from sustainable forests and are produced in highly automated factories. This AR tool was only for promotional and educational purposes.

Figure 13: Story of Eco Pavilion explained with an interactive and funny AR application.

Automated BIM visualization and BIM Cloud

In this “chapter” there were a few “demos” that were made during the project. Below, the different activities done by the HEAL developers are listed, to get a better understanding of possibilities and challenges associated with automating the BIM process and quickly getting IFC models exported into gaming engines for visualizing the data in a VR experience. The objective was to have a practical tool for architects who would be able to engage their own customers better in the design process by visualizing the model and making it possible to make some small changes in the virtual model and bring them back to the original IFC model again.

The activities and demos done during the project related to BIM automation:

- Exporting BIM to Unreal or Unity
- Validation of BIM – xBIM + simple BIM validator demo
- Dynamic BIM model – BIMserver, xeogl, challenges, opportunities + demo
- BIM Cloud – demo
- BIM Cloud -design and architecture
- IFC compression and optimisation
- Solibri Autorun

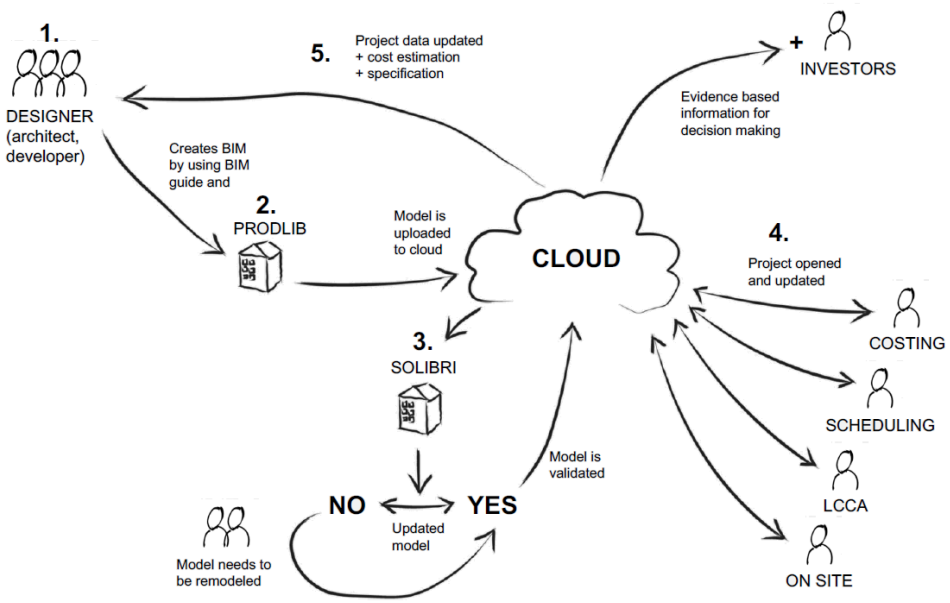

Figure 14: BIM Cloud "draft".

This part of the work was the most challenging, as the whole BIM issue is not about a specific tool, but moreover about a change in the way the whole process works. BIM is not so much about the model, but much more about the management of whole building process. At it is a very complex issue that is not resolved in a demo. But all the work done during this project was important for getting more understanding of IFC model content and what can be exported and/or imported easily.

6.1.3 How well the objectives and outcome for demo planning and execution were fulfilled?

The HEAL team took the challenge for planning and executing various different demos in a very short time frame, as the Seefeld project was already in February and it was a great opportunity to have demos related to a real building. If there would have been more time for planning, probably the outcome would have been even better. Some things that the HEAL team would have liked to trial also in Seefeld were not possible due to limited time, such as having a proper indoor air quality analytics company working on the collected data or having the indoor air quality sensors also located in the architectural BIM model in the correct places. Now they were installed in the building afterwards and only marked in the drawings afterwards. These lessons will be taken in consideration for future pilot projects.

Nonetheless the objectives were fulfilled well, even having more demos prepared for Seefeld compared to our original plan. In addition to the AR/VR demo, testing BIM automation and having IoT data collected from indoor quality sensors, the track and trace technology (already previously tested at Stora Enso in other divisions) was also included in the Eco Pavilion case. All these demos were carefully planned with user stories, including potential user benefits, finally executing the demos and showing them and testing them in Seefeld as well as in other events/occasions for feedback and further development.

When it comes to individual demos, the following can be commented about their “success”:

- **Healthy Living App:**
    - In the limited timeframe there was enough time to learn about specific sensors, connectivity issues, storing data in the azure cloud and setting an online portal
    - What is still lacking and needs to be the next step is the analytics part which requires more data, and professionals to “analyse” the data correctly
    - Most probably HEAL will be looking for collaboration with other start-ups or existing companies to integrate a service into HEAL’s toolbox
    - Definitely this type of service is something that HEAL and Stora Enso are interested in investing into for the future

- **Track and trace:**
    - Some work had been done already before at Stora Enso on this, especially on tracking of packages in the packaging division
    - In the Seefeld case the track and trace of wooden building elements (LVL from the Varkaus mill and CLT from the Bad Sankt Leonhard mill) was implemented successfully
    - Our active track & trace POC showed that it is technically possible to track & trace CLT & LVL elements through the whole supply chain and also monitor moisture, shock and temperature situation all the time
        - Active tracker technology is still under development. Vendors tend to promise a lot, but quite often devices fail or have some drawbacks in real life tests.
        - In general, active trackers seemed to work pretty well in different locations. Roaming caused some challenges when deliveries crossed country borders.
        - Active trackers are still quite expensive devices. It is important to prepare a good model for returns & reuse (including reloading of batteries).
    - Next steps of this App are already on-going

- **BIM automation and visualization:**
  - Some clear steps were taken into the right direction, although it needs to be said that it is essential to collaborate at the industry level to get first the material definitions standardized at the IFC at the European level. At the moment no standards exist, and it makes the transfer of data between different programs very challenging.
  - Compared to the first VR model that was done with the HEAL developers from the Woodcity IFC model and which took days to get done (although the final result was really good), in the Seefeld case the work from transferring IFC model into virtual model took no longer than 7 minutes. It is still not fully automated, but during the project, clear instructions for the transfer of data from IFC model to Unreal gaming engine were written.
  - Simple tasks like taking a wall and stretching it longer or wider were possible to make at the virtual model level and bring back to the original file model (IFC), but IFC still has quite a lot of limitations for complex tasks.
  - Also, it remains to be seen how well architects will accept the VR technology as it still lacks many “dimensions” that would be very relevant for architects for wider use (such as great audio and multi-user functionalities). Great visual quality is also a must.
  - The work done during the project resulted into new areas of work (collaboration with Solibri or Trimble for example) that will be now continued.
  - Stora Enso is also participating now at Building Smart as an international member and will be working actively on the standardization issues.

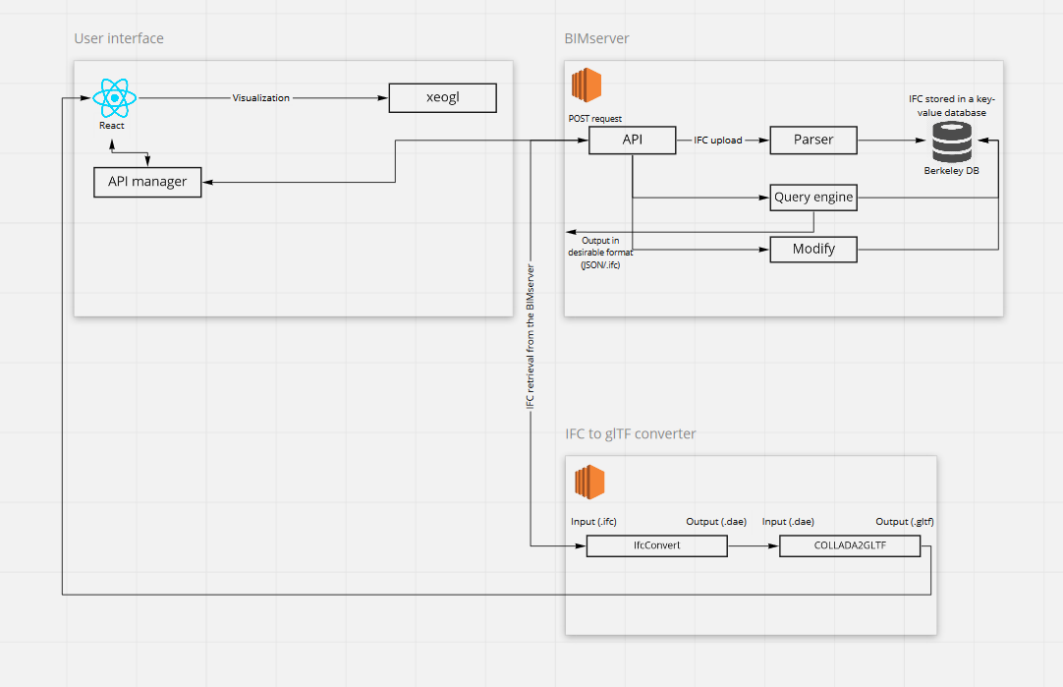

Figure 15: Dynamic BIM model, Sketch.

6.2 Results from user testing and validation

6.2.1 Planning and execution of user testing

An important part of the HEAL working process is to learn about stakeholders and especially about their pains in the very beginning, prior to starting demo planning. Further on, it will be important to get feedback on the demos and understand better what needs to be improved so that those future “tools” could resolve best some of the pains we’ve defined. For this purpose, HEAL has used various methods, starting from using simple visitor feedback from events (BAU 2019 in Germany, Seefeld Ski event and Glass Performance Days), making well planned expert interviews (in the case of the Healty Living App) or facilitating workshops for better understanding (see the full list in the next table).

Depending on the method, the planning phase also varies. It is simple to formulate a questionnaire for user feedback at an event and collect it via a mobile application, but it is totally another preparation needed for a proper validation workshop. And more than planning the workshop, the biggest work is with the analysis of the results and trying to make sense out of the feedback and workshop results. That requires time and dedication, which fortunately was possible during this project with the great service design team at HEAL.

To arrange proper user testing is clearly its’ own art and requires professionals to make it happen. The experience from the very first user testing and workshop with architects made it clear, that it is essential to consider such an event as not only user testing but moreover a great opportunity to learn more about the pains and gains of the target group and also promote wood construction to them in general. The feedback from such an event is normally very positive as it is something that is generally not much done among the industry.

Even architects themselves hardly go back to those buildings they have designed and arrange feedback sessions with the occupants and/or owners to learn what has worked well and what could be improved. This could help a lot to design better functioning buildings in the future.

Many activities and events listed in the table below were both for testing the demos and ideas behind them and get validation for the work done. But they were also arranged to get improvement ideas and get the demos into next stage for piloting in different projects for example (in case of BOKU project, with Saint Gobain etc.). Feedback from events and workshops have been mostly very positive and it has given validation of the direction that HEAL should take. Some of the results have shown, such as in case of VR, that it works as a powerful promotional tool, but the technology is not yet mature enough to get full (business) benefits from it. Having said that, HEAL will still continue working on this technology.

The following table shows what methods and events were used to collect feedback on the demos that were developed during the project and what type of results were gained.

Table 1: User testing and validation: Events, interviews and workshops.

Location or event	*Customer group(s)*	*Method used*	*Results*
BAU 2019	Architects, building companies	Feedback survey	Report
Seefeld (Eco Pavilion)	Consumers (regular visitor)	Feedback survey	Report
Seefeld (Eco Pavilion)	Wood builders / carpenters	Workshop	Report and another workshop
Graz, Austria	Wood builder / distributor	Workshop	Project proposal
Paris, France	Property developer	Workshop	Project proposal
Helsinki, Finland	Architects	Workshop	Report
Helsinki, Finland	Saint Gobain Finland	Workshop	Project proposal
GPD, Tampere	Architects / glass industry	Feedback	News article
Healthy Living App	Stakeholders involved in Woodcity project	Expert interviews	Report
Bio-Playground	Consumers	Feedback	News article
Vienna, Austria	BOKU project participants	Workshop	Project proposal
*Wood Building Nordic**	Professionals from industry	Feedback survey	Report/News
*WDBE (Helsinki)**	Professionals from industry	Workshop	Report/News
	*Note: * means that the event is after the project duration (during September)*		

The following is a selection of pictures from events and workshops from demo validation with users.

Figure 16(a,b,c,d): Pictures from different events and workshops.

6.2.2 How well the objectives of user testing and validation were fulfilled?

This part of the project was really interesting, and the team got better at this when learning by doing. It was very useful also for developers to get engaged with possible users of the demos that they had been working on. It motivated team members to further develop and finetune the demos. Team also collected a lot of further ideas (saved in a specific ideation tool that is now regularly used for discussing the new proof of concept proposals), some of which have been turned into new projects.

There is certainly still improvement potential, when it comes to finding objective ways to measure the success of the demos, based on user feedback. During this project mostly qualitative feedback was used and it gave enough good basis for going forward (or not). In the next projects (and when more tools are under way) it will be important to use also quantitative feedback and get more KPIs defined.

In general user feedback of the presented demos has been mainly positive, although it is always much easier to get “real” feedback first when the tools have been used in a real project. Normally building professionals want to see the real benefits before they give the final “approval” and this is not very easy having only a proof of concept “version” in hand. During the project many valuable feedback for next steps have been collected, and some projects have been already started based on the user feedback.

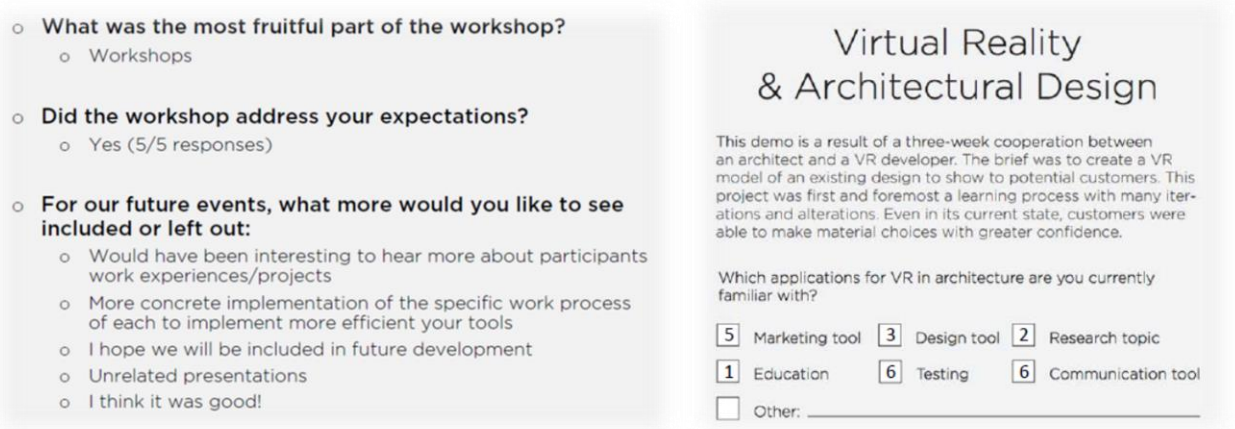

Figure 17 (a,b): Examples of user feedback from demo validation workshop (architects).

6.3 Results from communication plan and execution

6.3.1 Planning and execution of communication activities

An important part of this project was to share the doings and results both internally at Stora Enso but more importantly externally among wider public. Communication and “branding” of HEAL activities was one of the key tasks during this project and will be continued also after this project. Important objective was to share openly what is being done and what is coming next.

First a planning workshop was arranged to define the target groups (and more specifically the “personas” that we want to target) and the story that we want to tell. We worked together with an external company to start with market insights, trends and understanding our position as HEAL. Then we started to work on the visual image and brand (not part of this project) and finally think about the exact deliverables, including different communication activities, channels and responsibilities. We used a format to work on those deliverables (see the next picture) which helped also to see how different tasks are related to each other and what needs to be done first.

Figure 18: Initial ideas for communication materials using an artist (finally did not fly).

Deliverable	
Responsibility	
To	
Dependent on	
Date:	
Tasks	

Figure 19: Communication deliverables were defined using this simple format.

As the team needed to test the initial demos and get feedback to those, there were two events coming fast (BAU fair in Munich and Nordic Ski Championships in Seefeld), which were a great opportunity for HEAL to get visibility both internally at Stora Enso but also externally among different stakeholder groups, including at least architects, construction companies and finally also consumers (in Seefeld). In addition to these key events, there were many other channels and events, that were used for communication both internally and externally. See following the main channels/events used:

Table 2: Communication activities during and after the project.

Activity/Event	Channel/place	Target group	Date	Purpose
RecoTech 2018	Helsinki (Slush)	Tech & construction	6.12.2018	Visibility and contacts
BAU 2019	Munich	Architects and construction companies	14-18.1.2019	Visibility, feedback and new contacts
Eco Pavilion	Seefeld, Austria	Building professionals and consumers	23-28.2.2019	Visibility, feedback and info sharing

SE Investor day	Helsinki	Stora Enso forest owners and other investors		Visibility and sharing information
GPD 2019	Tampere	Glass industry players	27-28.6.2019	Visibility and contacts
Bio Playground	Helsinki	Consumers	19-22.7.2019	Info sharing
WBN Forum 2019	Helsinki	Wood construction industry	26-27.9.2019	Visibility, info sharing
Articles and blogs	Heal website	General public	Continuously	Visibility and info
Article	Leaf review (UK)	Architects & designers	July 2019	Visibility and info
Articles and news	Social media	General public	Continuously	Visibility and info
Articles and news	Yammer	Stora Enso employees	Continuously	Visibility and info
Ideation workshop (WS)	Seefeld, Austria	Architects and (timber) construction companies	24.2.2019	Info sharing and testing ideas
Validation WS	Graz, Austria	Stora Enso customers (ZMP, Woodcon)	7.5.2019	Info sharing and testing/collecting ideas
WCEF 2019	Helsinki	Circular economy players	3.6.2019	Visibility, info sharing
Opportunity WS	Paris	SE customer (Woodeum)	24.6.2019	Collecting new ideas
Opportunity workshop	Helsinki (WDBE Summit 2019)	Construction and tech professionals	25.9.2019	New contacts and opportunities

A lot of work was done to make good materials and presentations to be shared both in events and through different media channels, especially at HEAL website and different social media channels. HEAL activities have been branded separately from Stora Enso as we are only one partner of HEAL and the target groups are also different from Stora Enso. HEAL wants to target also consumers and other stakeholders that are normally not targeted by Stora Enso communication.

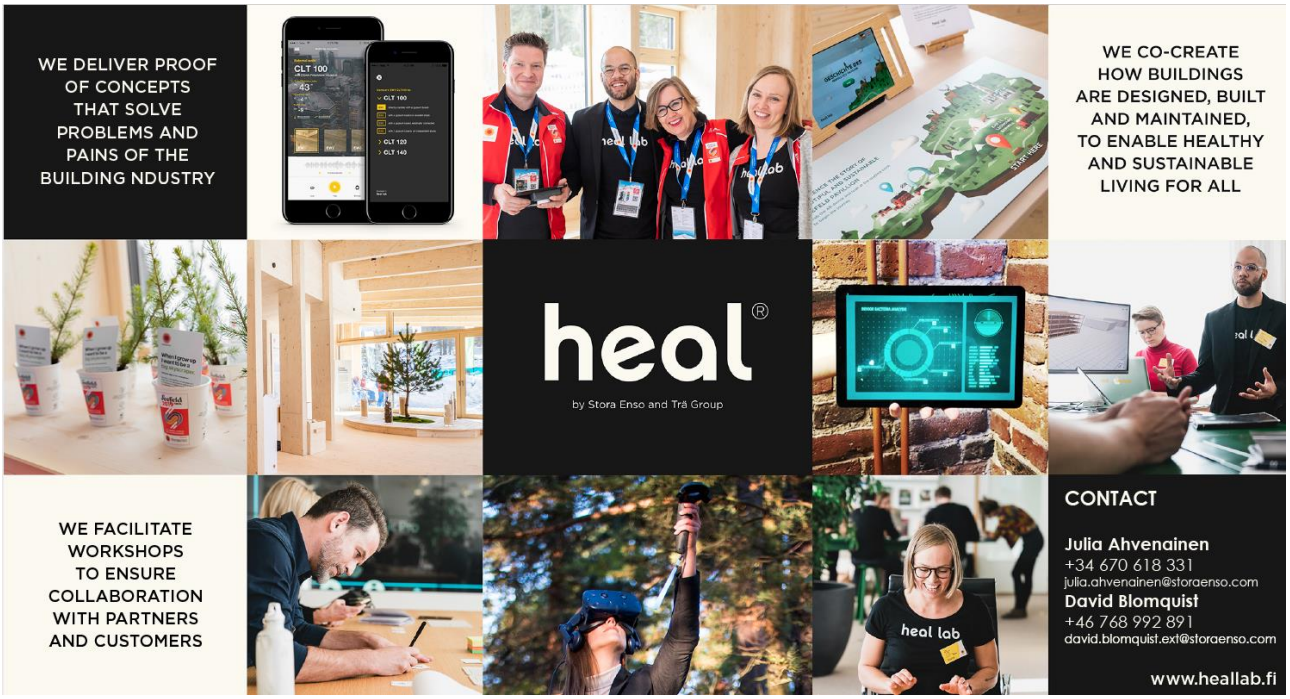

Figure 20: Example of HEAL communication (leaflet for events).

6.3.2 How well the objectives of communication were fulfilled?

Both the planning and execution of communication activities worked very well and HEAL has got very positive visibility inside of the tech and construction community, now being asked to participate in many events in Finland. The materials presented are of high quality and differentiate HEAL from other industry players. Due to steering group decision, some changes in the target group setting of HEAL were made during the project. This meant that for example the importance of consumers was put lower that it was in the beginning. Now the important target groups are (timber) construction companies, property developers and investors.

What still needs to be improved is to get better evaluation mechanisms in place when it comes to measuring the coverage and effectiveness of the communication activities. Currently it was possible to measure only the number of people that visited at the events or HEAL website or who have read or liked the postings at social media. Some feedback was collected on the satisfaction of visitors at events and workshop participants, which was always mainly positive, but more work is needed to get more specific data and make it as a tool to help to target the communication activities into right channels. This requires careful planning and also resources to collect and analyse it properly. As the team grows this should be one of the tasks for the communication team.

In general, the outcome from the communication plan and activities has been very positive and the good work should be continued after this project. The positive feedback has led to many new contacts, both to new industrial and technology partners, as well as academia and research. What probably will be more challenging task is to reach to wider public, especially consumers as it needs a very extensive and intensive communication campaign.

Perhaps the best way to estimate the outcome of communication is to give a few examples/quotes:

- *Today, HEAL Lab and Stora Enso brought a humanistic aspect in to the discussion about technology. Thank you!* – Swedish architect after participating in a HEAL workshop
- *This was the best workshop that I have been participating for a very long time* - architect after the WDBE 2019 workshop facilitated by HEAL
- *I have been researching the issue of taking the user centric approach into construction and I was so happy to see that someone has already using that approach in practice* – a researcher from Helsinki university after she had been listening to HEAL presentation

7. Impact

The project was fairly widespread with regard to scope and the various touchpoints across the wood building value chain. We communicated with wood engineering professionals, sustainability experts, construction workers, developers, software companies, iot technology startups, hardware manufacturers, marketing companies, architects, and the general public. Consequently, the project had a number of both positive and negative impacts on these companies and individuals, and the wood building industry as a whole.

Perhaps the most impactful component of our project is that it gave us, and those we are working in collaboration with, a clearer understanding of the massive scope of our mission to improve the building sector. We learned first-hand through our demos, testing, and interviews that we are grappling with complex problems that require intimate knowledge of the problems and their origins. Often the knowledge necessary to resolve these problems exists across different expertise in the sector. Communication and collaboration will be essential aspects for improving our built environment – this understanding was affirmed by our initial work in the field, and hopefully was well articulated to all those we worked with over the course of the project. We believe the workshops, in particular, highlighted these particular subjects with industry professionals and galvanized the importance of continued, structured communication.

As related to impact of the project to wood industry, it can be said, that it has gained a lot of interest both from wood building companies as well as material manufacturers (including competitors of Stora Enso). This was particularly visible at BAU 2019 fair, where many of the industry insiders gave positive feedback on the relevant work that Stora Enso is carrying out, trying to automate and digitize the industry. In other industry events, latest on Wood Building Nordic, the work that HEAL is carrying out, gets a lot of positive attention. It hopefully helps to change the mind-set of the industry and works as a good example that others want to follow.

It would be too much said, that the current Proof of Concepts would change significantly the industry, as they are only intentions to do things differently, but it would probably be dangerous not to do anything and just continue manufacturing wood products as always. Other players outside of the industry (e.g. Amazon and Google) are already looking into disrupting construction industry as well. Big companies such as Stora Enso cannot afford to take a “wait and see” position, quite the opposite, they need actively work on new services and try to connect themselves with other players in the same ecosystem.

Additionally, this project provided a positive mindset shift across the Wood Products, one of Stora Enso’s divisions. HEAL successfully highlighted the importance of service design thinking, and the importance of communicating with customers and other players in the wood building value chain. Embracing new digital technology is an exceptionally important process for the manufacturing industry, but digital technology cannot be used to resolve pain-points, and implementation will be extremely difficult without dedicated effort towards many of the methodologies we have focused on at HEAL. The impact on Stora Enso has proven valuable enough during this project to secure future investment.

8. Endurance and utilization of the results

The largest conclusions we’ve drawn at HEAL are often non-metric in nature. We have been focused on methods and established systems for joint collaboration for innovation and improvements in the building sector. The largest part of our mission has been to do research and test the effectiveness of various methods while working in partnership with companies. We hope that we have impacted the way professionals view problems in the industry, but our discoveries are most likely to endure if our partners establish working methods which embrace service design thinking, agile development, and active communication and cooperation with diverse subsets of wood building value chain.

On a more granular level we have made many discoveries and learnings through the proof-of-concepts we developed. We have documented these findings and will continue to share this information with all those we collaborate alongside, and through our publications. These minor findings will persist as long as the technologies and problems they grapple with remain relevant.

Our most enduring work is helping large players in the industry shape their working methods to have a greater focus on user engagement, and trans-company communication, research and development. Our comparatively minor technological results are incremental, and necessary improvements meant to validate the importance of why companies should embrace new working methods which are better adapted to a digitally oriented society, that is better attuned to health, wellbeing, and climate change.

Our work has also been important to bring the sustainability and even resilience as well as healthy aspects into wider discussion. Building industry is trying to keep the status quo, especially related to more sustainable materials, energy efficiency and waste as it means changing the way of working and totally new mindset, where the whole lifecycle needs to be considered, instead of only the design and build phase. Hopefully our communication efforts and examples help other players to start thinking about sustainability and healthy aspects in their own processes and policies.

9. Financial report

The following table shows the costs related to this project. Auditors' statement can be found in a separate document attached to this report.

1. HANKKEEN TIEDOT

Hankkeen nimi ja diaarinumero	
Innovative Digital Services for Wooden Buildings (InDiSe) VN/5291/2018	
Toteuttajaorganisaatio/yksikkö	Vastuuhenkilö
Stora Enso Wood Products Oy Ltd	Julia Ahvenainen
Muut osallistuneet organisaatiot	
Trä Group	
Rahoittajat ja rahoitusosuudet prosentteina kokonaiskustannuksista	
Stora Enso Wood Products Oy Ltd (50%), TRÄ Group (50%)	
Raportointikausi	
1.11.2018 - 31.8.2019	

2. TUKIKELPOISET KUSTANNUKSET

Tukikelpoiset kustannukset	**Raportointikausi** 1.11.2018-31.8.2019		**Yhteensä**
Henkilöstökustannukset			**26 933,94 €**
Julia Ahvenainen	18 548,18 €		18 548,18 €
Reeta Stöd	8 385,76 €		8 385,76 €
Välineet ja laitteet			**2 713,00 €**
i-Padit	1 835,00 €		1 835,00 €
Puiset raamit	878,00 €		878,00 €
Asiantuntijapalveluiden hankinnat			**163 757,24 €**
Palvelumuotoilu ja demot	126 762,90 €		126 762,90 €
Konsultointipalvelut	16 434,34 €		16 434,34 €
Brändi ja viestintä	15 950,00 €		15 950,00 €
Tilintarkastajan kulut	4 610,00 €		4 610,00 €
Muut yleiskustannukset			**469,15 €**
Meeting (workshop) costs	451,49 €		
Postal costs	17,66 €		
Tukikelposet kustannukset yhteensä			193 873,33 €
Haettava avustus		40 %	**77 549,33 €**

3. MUUN RAHOITUKSEN JA TULOJEN ERITTELY

Muut rahoittajat, mahdolliset muut avustukset, mahdolliset tulot	**Raportointikausi** 1.11.2018-31.8.2019	**Yhteensä**

4. HANKKEESEEN KÄYTETYN TYÖAJAN ERITTELY

	Avustuksen saaja	Muut organisaatiot	Yhteensä
Projektin toteutuneet työtunnit	510	Trä Group (ei raportoitu)	510

10. Learnings

The development of digital services and tools at Stora Enso Wood Products is very new. First Proof of Concept was started just a few years ago. The collaboration with TRÄ Group and establishing HEAL happened only 18 months ago and it has been a continuous learning process. Instead of normal project management practices, digital tools are developed with agile methods which require totally different skills and resources. Especially the agile and intensive 2 weeks' development sprints need a proper product owner who give the developers not only the tasks but also know how to prioritize those in a right way. At the beginning of this project we did not have a proper product owner, which made the work for the development team very difficult. To nominate person who can only spend 20-30% of her/his time as the product owner is not a good solution as it postpones tasks for the development team and is very frustrating for everybody. That is one of the key learnings for the development of PoCs.

Another learning is to have very clear use cases that are defined together with the potential users. It makes no sense to intent to understand users' perspective and develop PoCs by making best guesses. It is much better to involve them to the discussions and planning from the beginning. That way the projects have clear user stories that can be developed fast and tested easily. Having the users in the middle of development is something that has not been always the case in wood industry projects. Use of service design methods helps to give structure both to collect user insights and validate concepts.

During the project we also realized that the building value chain transformation (digitalisation) is an enormous challenge and can only be done bit by bit and that it was better to concentrate more on the design and build phase than trying to cover the whole lifecycle. There are already a lot of companies and technologies existing that have developed some parts of the building value chain, so what HEAL also know tries to do is to scout those companies and technologies and bring them under the same "platform". It does not make sense to develop everything from zero but to bring companies together and benefit from synergies and develop a holistic concept.

In comparison to Stora Enso's traditional product development, HEAL has also showed that it is not always necessary to communicate first when a product is ready for the market. Actually, it is good to communicate continuously, even when the product is only at the Proof of Concept phase. That way continuous feedback is collected, and information is shared widely, which helps to test the concept and get new ideas from other actors. Sometimes the actual product is not even the most important thing, but to get right companies involved and get the collaboration moving forward.

Another important learning from our work is that too often all of us confuse demo concepts with realizable products. Demos and tests are vital for user-engagement, learning, and iterative improvement, but can sometimes lead people to believe problems are further resolved than in reality. Far more research, effort and resolution must be applied before solutions are found which will hold up the rigours of real-world application. Demos are just an effective starting point for our iterative process. We have found demos to be an effective means of interfacing with industry professionals, and users of buildings so that we can communicate our thinking and gauge their interest about the utility of solutions we are exploring. Demos fall short of capturing the complexity or wickedness of the problems we want to solve, and will never be a stand-in for fully laboured solutions, and we should do a better job of articulating this in the future with those who would most like to see our solutions released to the market.

For any manufacturing company who is used to have years long product development projects and work with their mostly internal development teams, it is important to give the “digitalization teams” their freedom to try PoCs with agile methods and engage people outside of the industry with different backgrounds. Many interesting ideas and innovations might come out from a totally cross-industry and heterogenous teams that do not have too rigid development agenda.

11. New ideas and projects

New ideas surged during the project were collected into Stora Enso ideation tool called WeNovate. Some of the ideas have been already analysed more carefully and some new projects have been kicked off as well. There are many new proposals. In the list below a few examples are listed:

- Use of BIM data and validation: Collaboration with Solibri to find validation for timber elements
- Use of VR: Application of AR/VR for training of timber element installation (for newcomers)
- Use of VR: Adding new “dimensions”, such as audio to VR to improve the user experience
- Onsite360: Combining claim handling and project time control into installation tool (CLT360)
- Piloting of different technologies and tools in BOKU university project in Vienna
- Configurator: Based on ideation with partners a new project has started to create a configurator for educational buildings (also funded by Environmental Ministry of Finland)

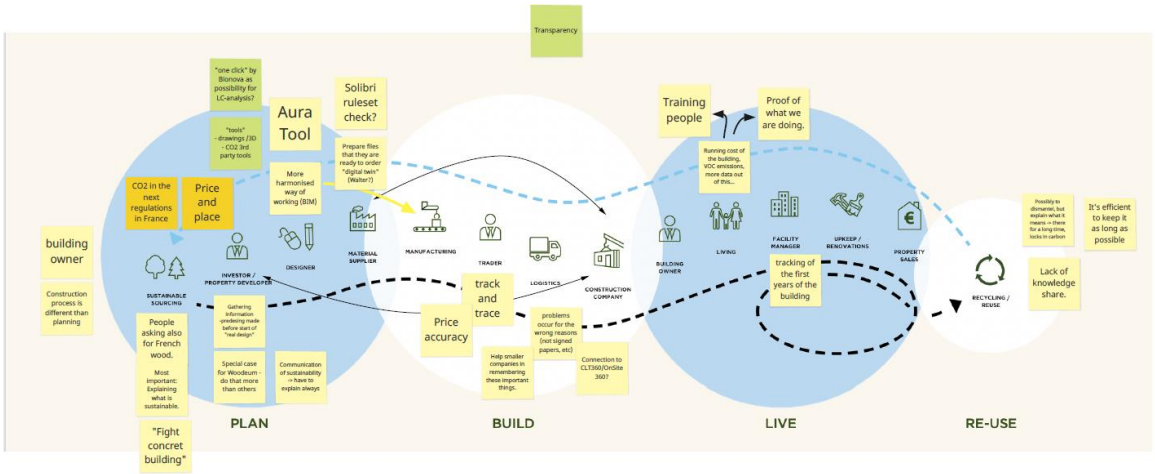

Figure 21: New ideas collected from user feedback.

12. Summary and key outcome

This project had an objective to test different digital (demo) tools in a real project, Eco Pavilion, that was designed and built in Seefeld, Austria, during the beginning of the year 2019. The tested demo tools are part of the HEAL's larger "mission" to make designing and building of timber buildings easier, more efficient and at the same time improve the health of the buildings and their occupiers.

Project was divided into three key activities: planning and development (execution) of the demo tools, evaluation and testing of demos and finally communication of the results. All these activities were carried out by using principally two main methods: service design and agile (scrum) development. Discovery team was mostly responsible for planning phase, after which the development team took over for executing the demos and after that discovery team helped to evaluate and test the demos. Finally, the communication planning was done in a smaller team consisting of the project manager and both TRÄ Group and Stora Enso communication professionals.

Both the final digital demos as well as the HEAL bigger vision has been shared widely in different media channels and during different events, both in Finland and other European countries. Feedback has been very positive and many different stakeholders, starting from other material manufacturers (e.g. Saint Gobain), property developers (e.g. Woodeum in France), construction companies (e.g. LendLease) and others are joining in the development to make healthy living more affordable through better collaboration, transparency and finally improved efficiency.

Key outcomes from the work done during the project are following:

- Good visibility of digital demos and HEAL story in industry events and media
- Impulse different stakeholders to collaborate in digitalization of the industry and more specifically to exchange information related to BIM standardization
- Bring sustainability aspects more visible in the construction industry and tech events
- Learn and experiment from service design and agile (scrum) development methods

As construction industry suffers from low productivity and is one of the least digitized industries, HEAL and its' activities want to impulse a change by starting a multi-disciplinary and cross-industry movement which will at the same time promote wood industry as a fore-runner in new technologies and automation/digitalization. This project was only the first step into that direction, but already now there are many ideas and new collaborations which have surged from the first demo projects. Many other "industry platforms" have similar strategies and missions, but they do not "make things happen". HEAL wants to take small steps by doing tangible demos and pilots, learn from them and share results.

One of the improvement areas for next projects is to find better ways to measure success and evaluate results, not only by qualitative feedback but also measuring other parameters. Another step is to start more collaboration with academia and research. By involving academia into HEAL activities and projects, the communication of results will have greater influence.

New ideas and projects were born during this project, some of which have been already kicked-off. BIM standardization for example is a topic that needs wide industry collaboration and HEAL has been working as a catalysator to bring different parties together, both from industry and technology side.

Now some of the demos tested in a small scale in Eco Pavilion will be piloted in bigger scale in BOKU university project, a 4-storey wood building that is now being built in Vienna. The feedback collected during the project from different stakeholders will bring the demos closer to become digital services that will help to make the whole process more efficient and transparent.

Another idea that has now turned into a project is a digital configurator that could help different decision makers and future building occupants to decide on which type of building they would like to have and this project is targeted especially for educational buildings.