EEBAK Indoor climate survey

Wellevi, Kittilä

LAPLAND UAS

20.9.2018

Introduction

To verify and analyze the quality of indoor climate in our project's pilot cases, series of measurement were conducted in similar fashion in every country taking part in this project. Measurement data included indoor temperature and relative humidity monitoring for 4 weeks, split in two measurement periods: first in heating season, and second during summer.

To analyze general user satisfaction and to detect possible defects and problems, a user survey was conducted in each pilot case. Users usually know the characteristics of a building best, since they are the ones spending most time in that particular building. It is also almost impossible to detect long-term variables and changes on a brief check to the pilothouse.

Pilothouse in Levi, Kittilä called Wellevi is educational & work-wellness center. The 800-squaremeter building located right next to Levi fell was built in 2014 by Rovaniemi Municipal Federation of Education as a student project. Besides accommodational and wellness services, the center offers authentic learning environment for students at Kittilä travel and restaurant school. Building has been used as a pilothouse before in EFCONE project, where building physical properties and functions of concrete elements were monitored for 2 years. C-wing of the building has hundreds of moisture and temperature sensors built inside concrete wall elements.

First part of measurements were conducted with very compact iButton data logging system. During measurements in other pilot cases, the iButton sensors were quite prone to failing, which led to a purchase of a brand new measurement system for summertime indoor climate monitoring. System acquired was Lascar Electronics EL-USB-2+ RH / Temp data logger system.

Measurements in Wellevi pilot house

Duration of all temperature and humidity measurement periods was at least 2 weeks. Measuring units were placed to most crucial rooms of a building to analyze conditions in spaces that are mainly used, which in this case were living room, kitchen and bedroom. Every sensor was set to identical height, and situated strategically to minimize direct sunlight and other possible error sources.

Picture 1. Measurement points in the Wellevi pilothouse.

Measurement interval was set to highest possible setting, limited by measurement instrument's memory capacity. On the first run on heating season, the interval was set to measure every 30 min. Heating season measuring period was conducted 15.3.2018 – 28.3.2018.

During the summer season, the new instruments made possible to record much more values on a single measurement so interval was more frequent, recording values once every five minutes. Summertime measurements were done 15.6.2018 – 10.8.2018. Measuring period prolonged due to summer holidays of Wellevi staff. More than months' worth of data was discarded, since we want conditions and timeframe of the measurement to be comparable with other pilothouses' data. Data from period 15. – 28.6.2018 was the data used and analyzed

Building info

Building type: Educational and work-wellness center

City: Kittilä

Purpose: Commercial

Built: 2014

Volume: 3117 m^3

Surface area: 800 m^2

Performed studies and measurements:

- CFD Simulations
- Monitoring of thermal and moisture behavior
- U-value measurements

Heating, water & electricity:

-Heat production: Geothermal heating & solar panels

User survey

User surveys were used in this case to get more complete picture of indoor climate and user satisfaction. Even though we are able to measure many different parameters of indoor climate, it is also crucial to analyze how users experience the indoor climate. Users are usually ones spending most amount of time in the building, so in theory they are most familiar with characteristics of building's indoor climate properties and other functions.

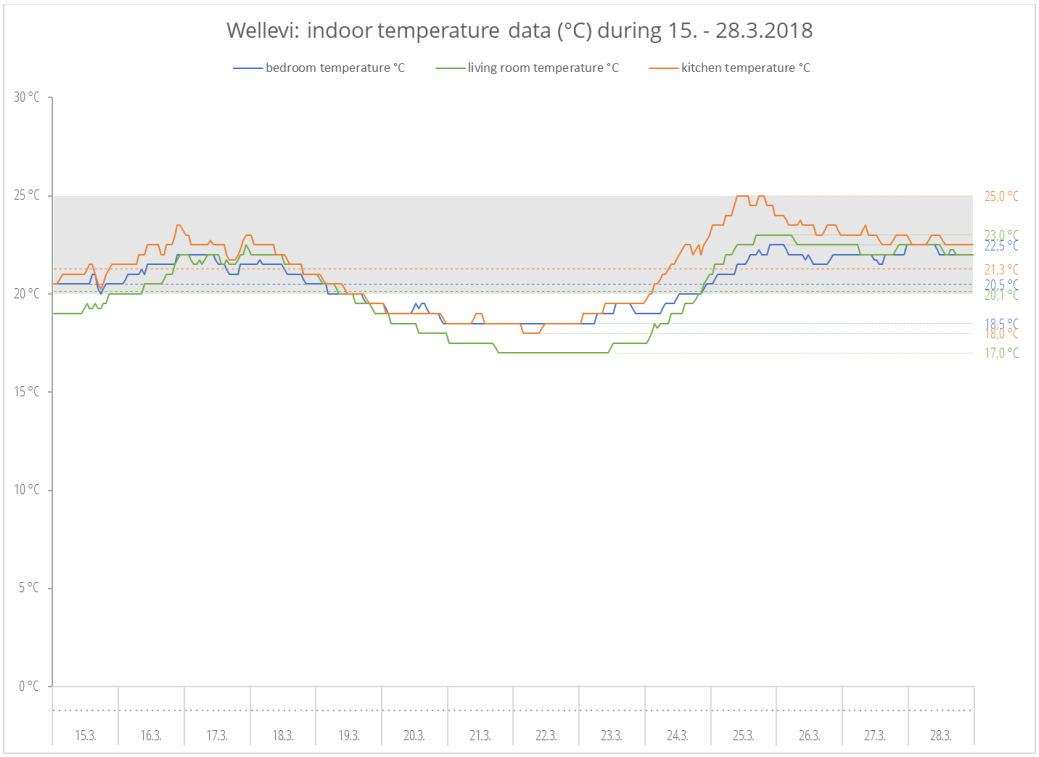
Uniform user survey was created so the results could be compared between different pilot cases. In this case, the questionnaire had to be translated to Finnish, but short, simple questions minimize the possibility of translational and linguistic errors and differences.

Scope of the questions was on the quality of indoor climate and energy efficiency. In the questionnaire, user is asked to describe his/her satisfaction regarding lighting, noise, thermal comfort, humidity and indoor air quality for example. Some simple yes or no-questions regarding mold growth are also included to detect obvious indoor air problems and possible health problems regarding them.

In this case, the surveys were not handed out to customers of Wellevi. Due to brief nature of their visit, the experience was considered too short to give actual insight on building's properties. Instead, we decided to collect answers from staff, who spend the most time in Wellevi. Due to size of staff maintaining place, there were no massive amounts of filled questionnaires.

Results

Heating season results



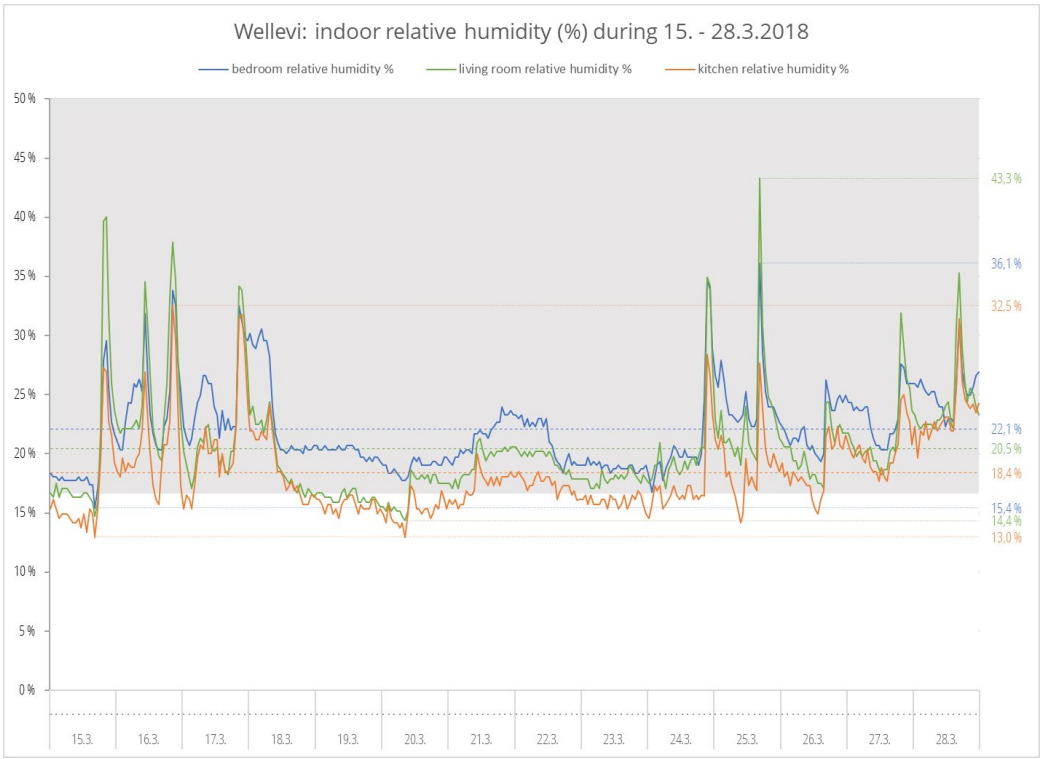


Figure 1 & 2. Temperature and relative humidity in Wellevi during heating season.

Living room

Average temperature of indoor air in living room was 20.1 °C during measurement period. There was no great deviations from average; minimum temperature being 17.0 °C and maximum 23.0 °C. Lowest temperatures may affect living comfort, and is present more than briefly. Drop of temperature is likely due to absence of users combined to slow reactivity of heating system.

Average of relative humidity was 20.5 %. Humidity was quite low during whole measurement period, and during final quarter of that time hit very low minimum values of 14.4 % RH, which may cause some discomfort. It is worth mentioning, that low relative humidity is unfortunately still quite typical in wintertime and hard to avoid while maintaining proper ventilation volumes. Maximum value of relative humidity did not reach alarming levels, topping at healthy 43.3 % RH.

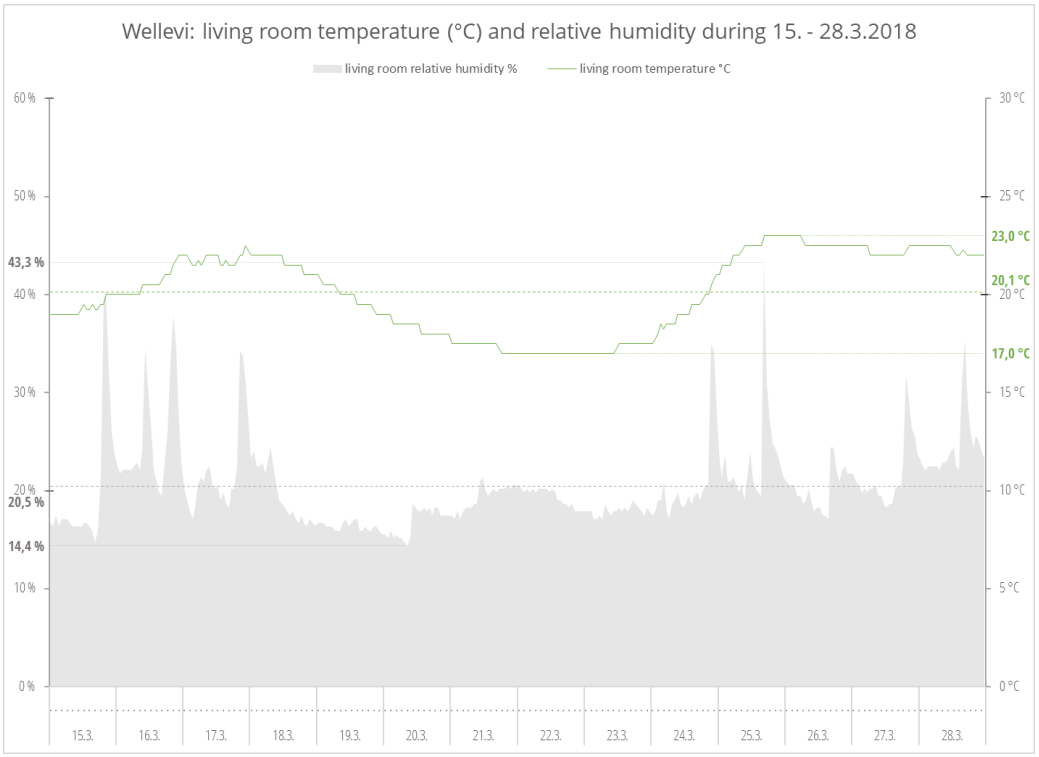


Figure 3. Temperature and relative humidity in living room during measurement period.

Kitchen

Average temperature of indoor air in kitchen was 21.3 °C during measurement period. Minimum temperature was 18.0 °C and maximum 25.0 °C. For most parts, indoor temperature is quite stable and on a comfortable level.

Average of relative humidity was 18.4 %. Humidity was in line with other measurement positions. Moisture did not reach alarming numbers though, maximum being 32.5 % RH. Minimum value recorded was 13.0 % RH. Measured valued presented practically identical findings with living room, which is logical when noting the fact living room and kitchen are located in same space.

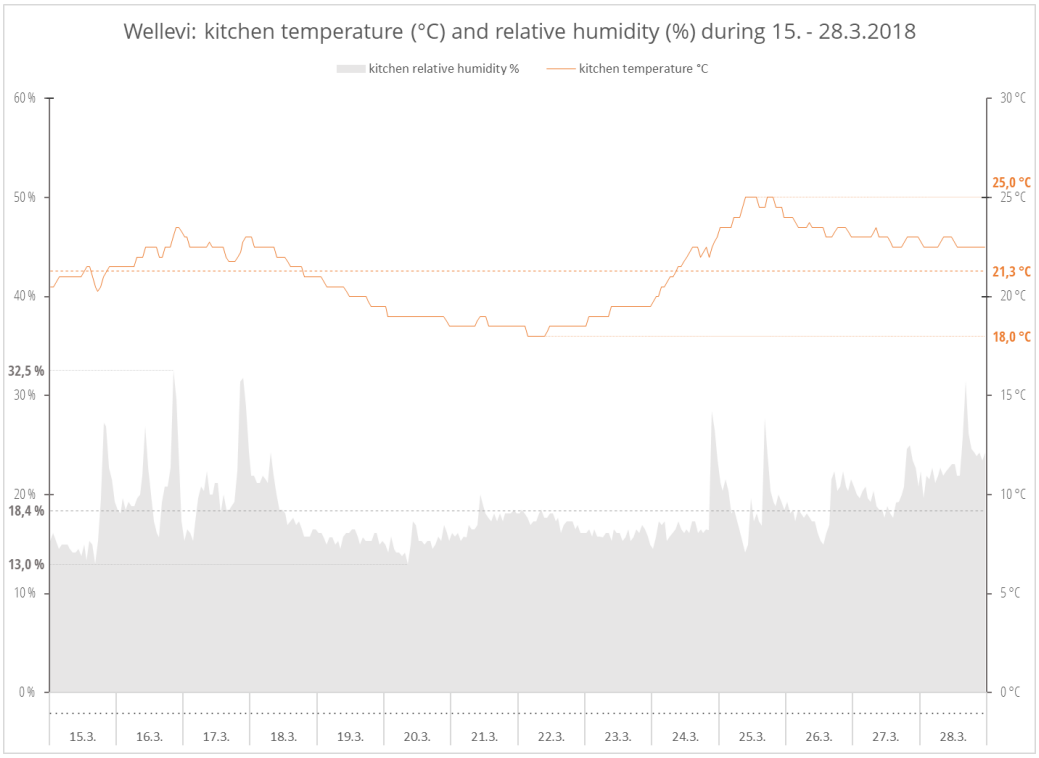


Figure 4. Temperature and relative humidity in kitchen during measurement period.

Bedroom

Average temperature of indoor air in kitchen was 20.5 °C during measurement period. Minimum temperature was 18.5 °C and maximum 22.5 °C. Temperature does not reach very high levels at any point. For most parts, indoor temperature is quite stable and on a comfortable level. One prolonged dip in indoor air temperature was present, which may have caused slight discomfort.

Average of relative humidity was 22.1 %. Again, humidity values were parallel with other measurement positions. Moisture did not reach alarming numbers, reaching maximum of modest 36.1 % RH. Minimum value recorded was 15.4 % RH. Relative humidity is on a safe level when it comes health of the building, but very dry indoor air may cause some level of discomfort.

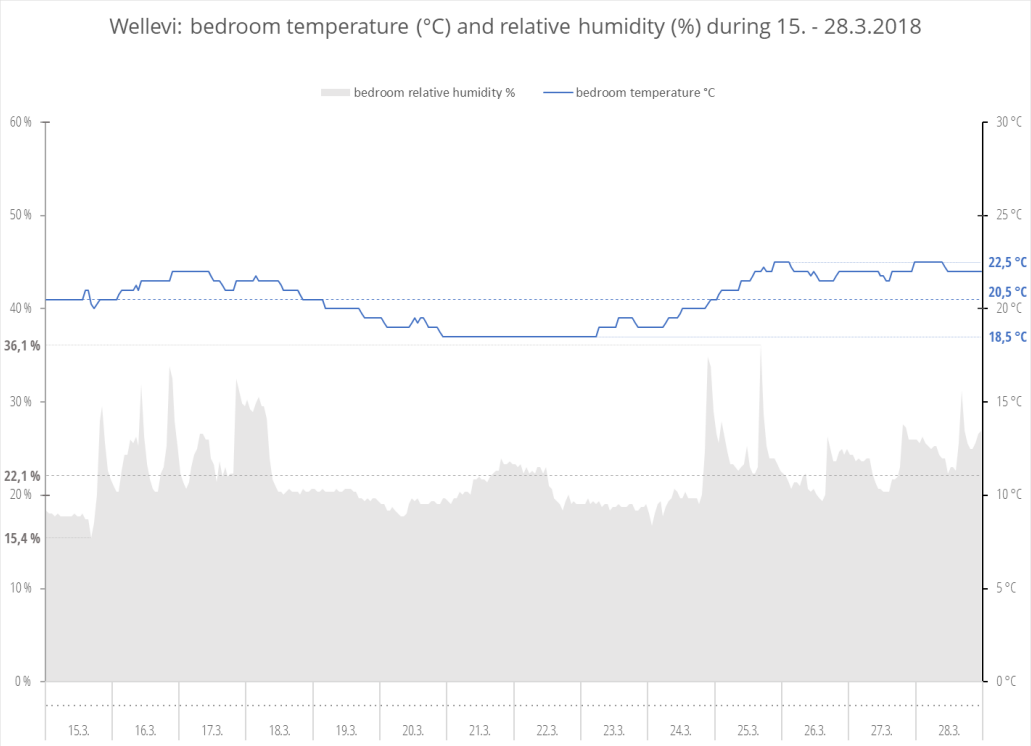


Figure 5. Temperature and relative humidity in bedroom during measurement period.

Weather data from winter measurement period

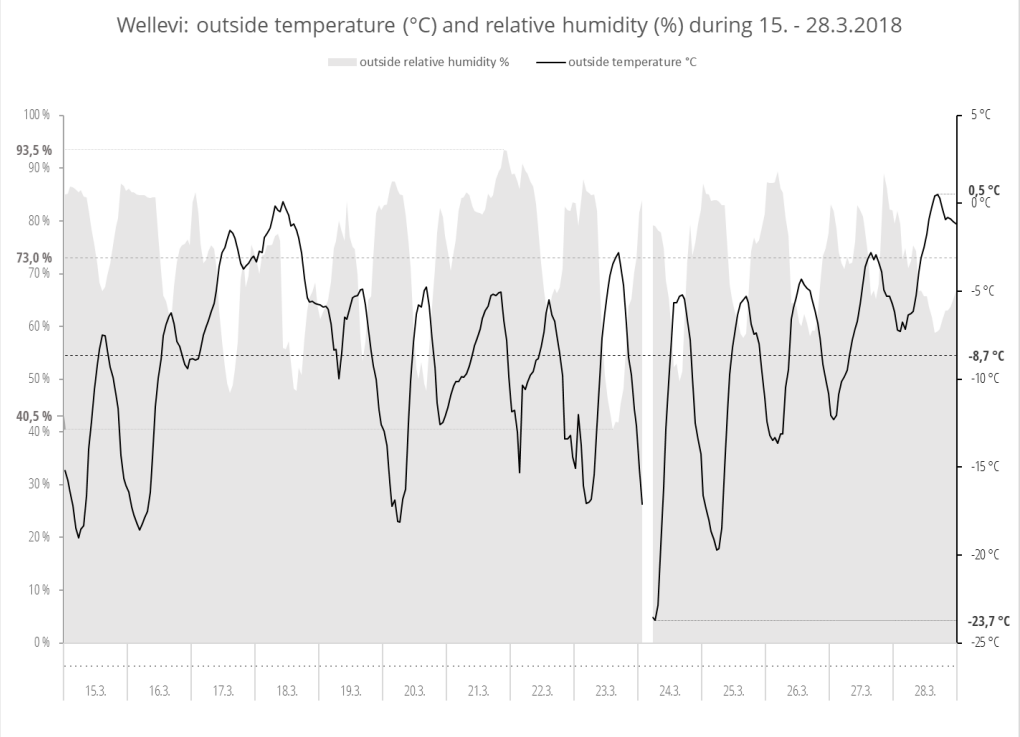
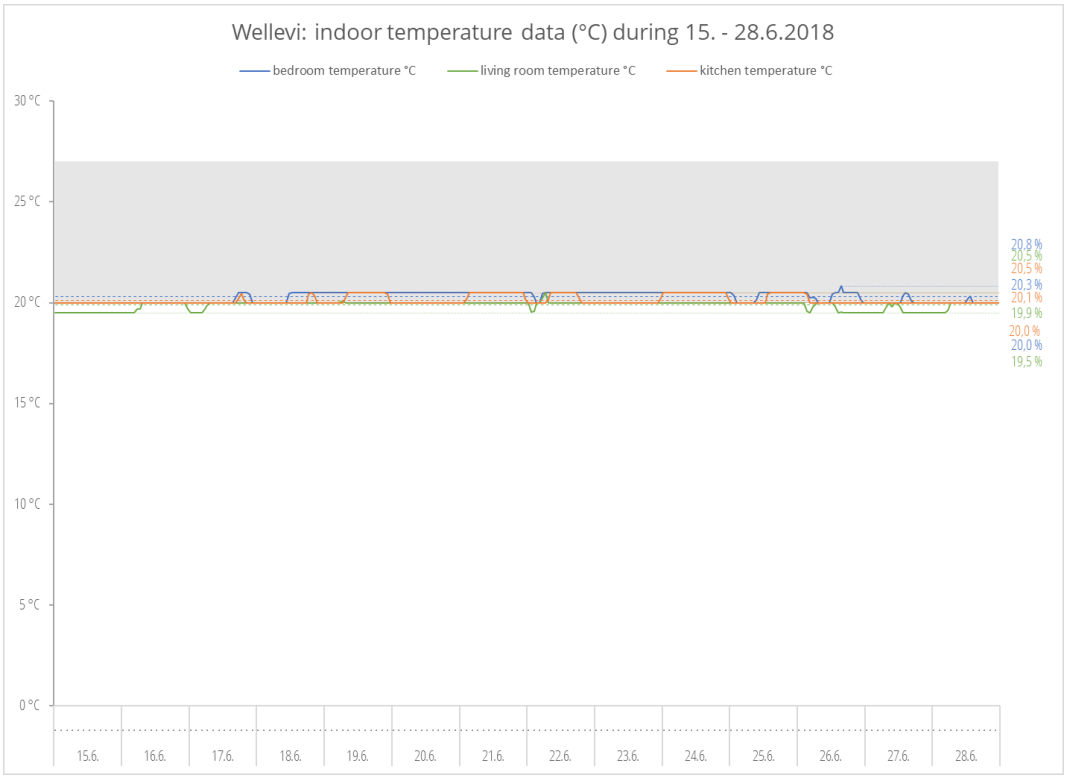


Figure 6. Temperature and relative humidity outdoors during measurement period.

Temperature outdoors during heating season goes through all typical temperatures of Finnish winter, temporarily above freezing point at warmest (0.5 °C) and – 23.7 °C at the coldest. These extreme temperatures and drastic changes in conditions put the structures to the ultimate test. Average temperature was – 8.7 °C.

Relative humidity is inversely comparable to the temperature, as expected. Relative humidity stayed almost completely above 50 % through the measurement period, average being 73.0 % RH. Highest recorded value was 93.5 % RH, and lowest 40.5 % RH.

Summer season results



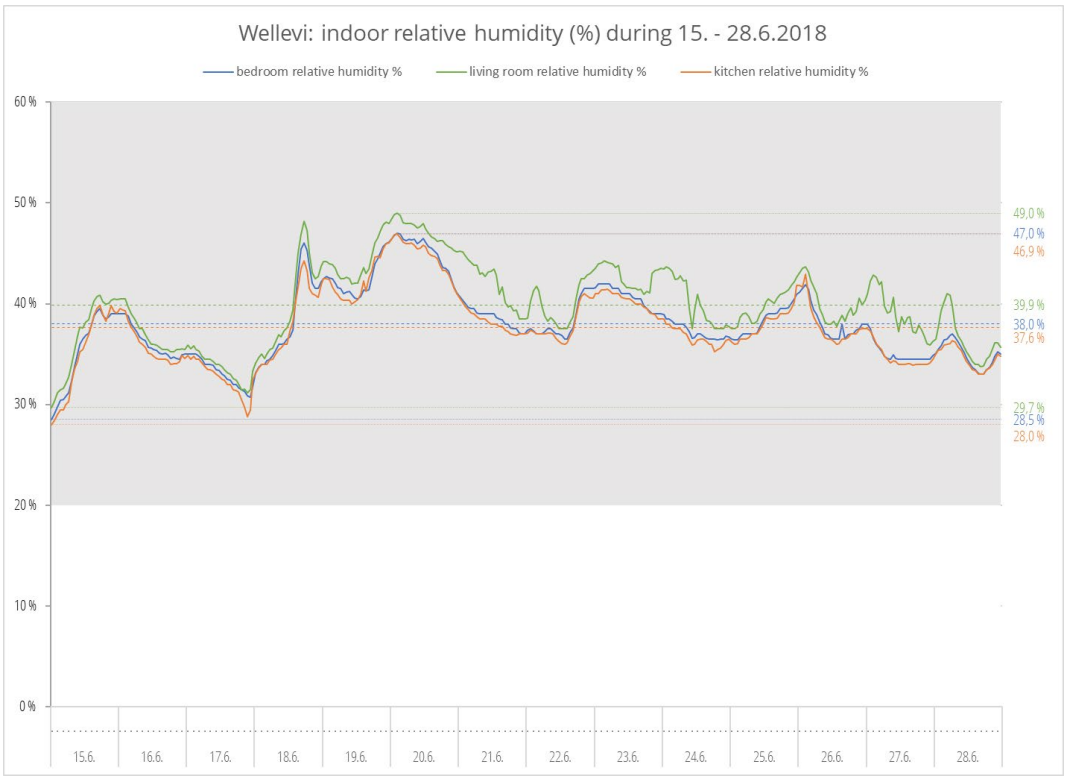


Figure 7 & 8. Temperature and relative humidity in Wellevi outside heating season.

Living room

Average temperature of indoor air in kitchen was 19-9 °C during measurement period. Minimum temperature was 19.5 °C and maximum 20.5 °C. Temperature is stable throughout the measurement period and stayed on a comfortable level for most parts. Random peaks just below 20 °C were present but they are not likely to cause noticeable discomfort.

Average of relative humidity was 39.9 %. Relative humidity is on a reasonable and comfortable level during entire measurement period. Highest measured level of relative humidity is 49.0 %. Minimum value recorded was 29.7 % RH.

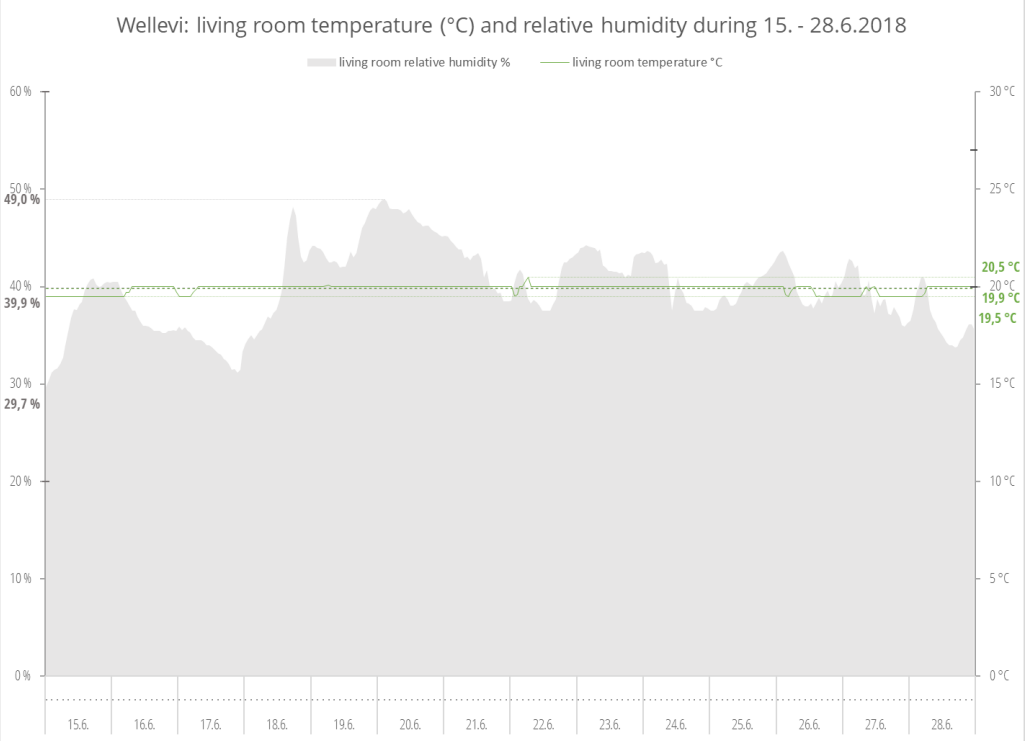


Figure 9. Temperature and relative humidity in living during measurement period.

Kitchen

Average temperature of indoor air in kitchen was 20.1 °C during measurement period. Minimum temperature was 20.0 °C and maximum 20.5 °C. Temperature was very stable and on a comfortable level through the measurement period.

Average of relative humidity was 40.0 %. Moisture did not reach alarming numbers, maximum being 46.9 % RH. Minimum value during measurement period was 28.0 % RH. Measured valued presented practically identical findings with living room, which is logical when noting the fact living room and kitchen are located in same space.

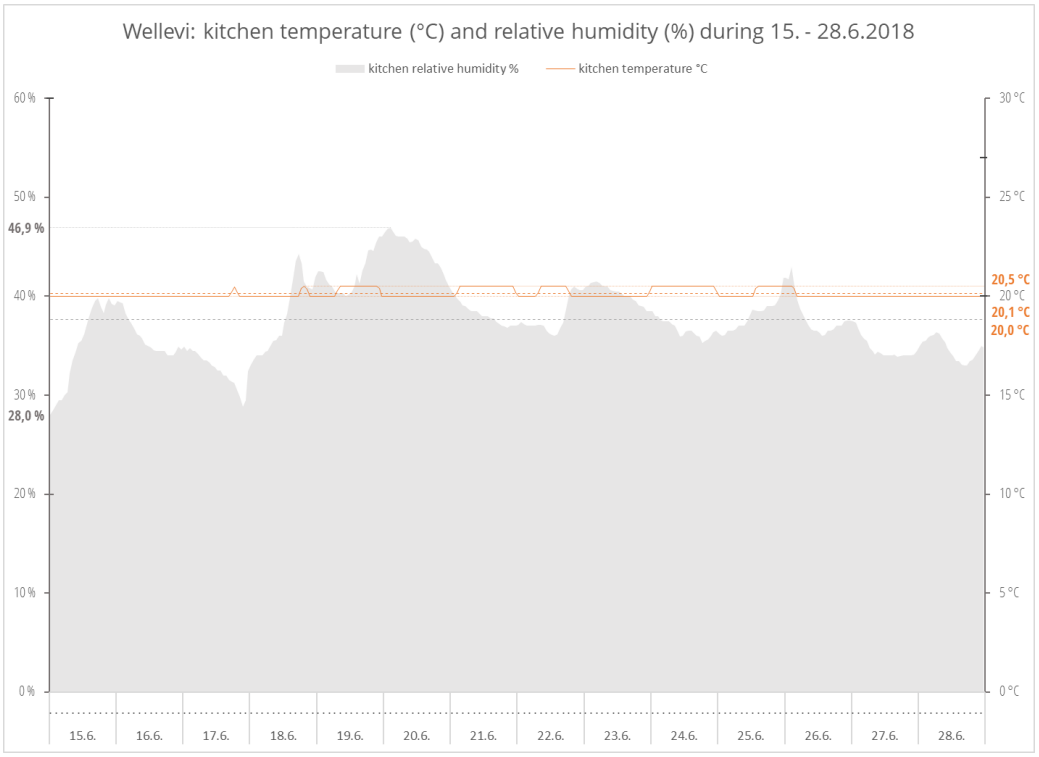


Figure 10. Temperature and relative humidity in kitchen during measurement period.

Bedroom

Average temperature of indoor air in kitchen was 20.3 °C during measurement period. Minimum temperature was 20.0 °C and maximum 20.8 °C. Indoor air temperature was quite stable and on an ideal level the whole measurement period.

Average of relative humidity was 38.0 %. Moisture did not reach alarming numbers, topping at healthy 47.0 % RH. Minimum value recorded was 28.5 % RH. Measured levels of relative humidity offers very comfortable indoor air.

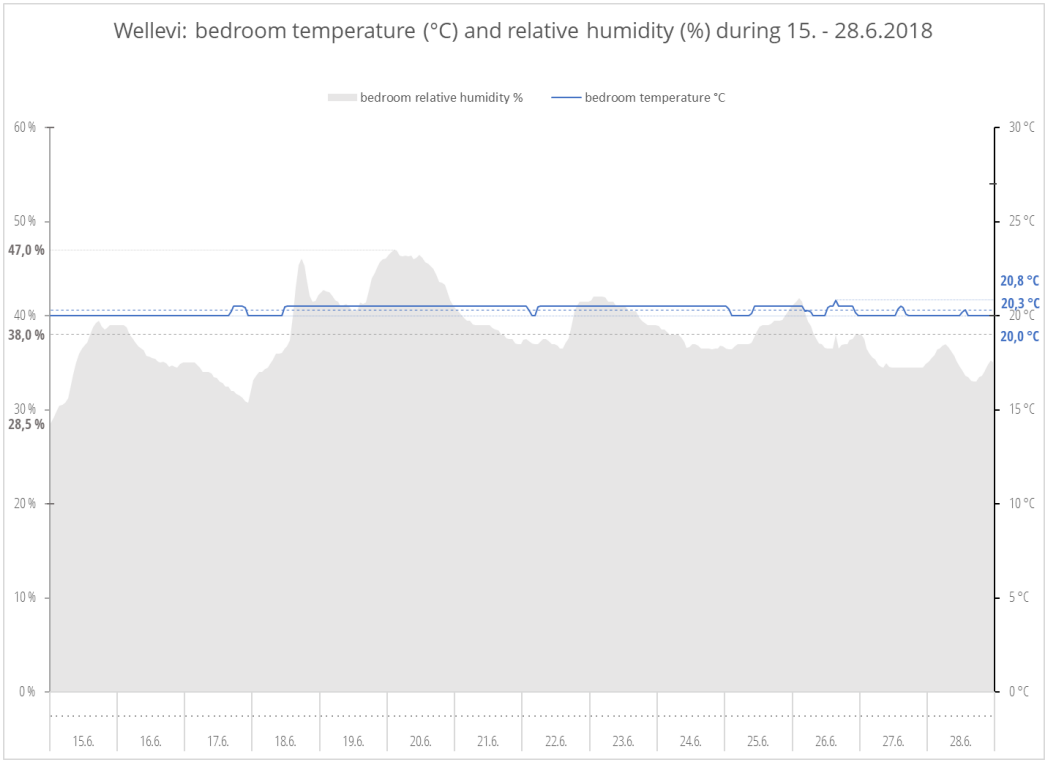


Figure 11. Temperature and relative humidity in bedroom during measurement period.

Weather data from summer measurement period

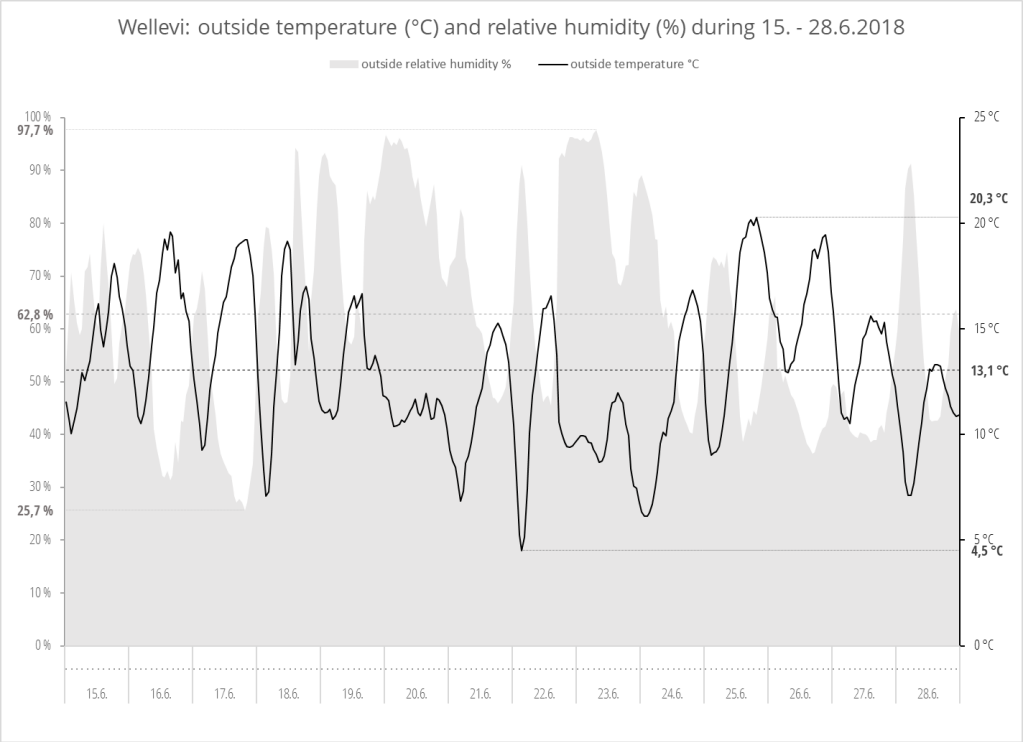


Figure 12. Temperature and relative humidity outdoors during measurement period.

Weather during summer measurement period represents typical weather during June in Finland. Average temperature during measurement period was 13.1 °C. Lowest temperature was recorded at the very beginning of measurement period, chilly 4.5 °C. Highest temperature was quite modest 20.3 °C, considering the heat experienced later during that summer.

Relative humidity follows temperature in inverse manner, and changes quite rapidly throughout the measurement period. Average relative humidity was 62.8 % RH. At lowest, relative humidity outdoor was 25.7 % and topped at 97.7 % RH.

User survey results

One filled questionnaire was received from Wellevi staff. Building has hundreds of visitors each year, but due to brief nature of their visit, it is not justified to collect data from them. Staff has been working there since 2014, when the building was built. No renovations of fixes have been done yet. Staff did not report of applying any energy saving measures or actions.

Temperature indoors is experienced to be cold often, and since the users have only little control over heating of the building, this is a discomfort that needed actions. Real estate management reacted to this by adjusting the heating system. On other aspects of indoor climate, users do not experience any discomforts. Users have not spotted any typical sings of mold growth or any other indoor health problems, and do not suffer from any medical conditions that could be related to poor indoor air health. Cleanliness of the pilothouse was rated to be excellent.

Frequently encountered deficiencies indoors were weak lighting and disturbing noises. Level of lighting is reported to be poor on the entrances and bathrooms of apartments, and so far, no actions have been taken to address this problem. Customers have reported about disturbing noise in apartments. Suspected cause of the noise is compressor of geothermal heating system, which led to additional sound proofing during summer 2018. Some reports have been made about noise of refrigerators, but no actions have been taken so far.

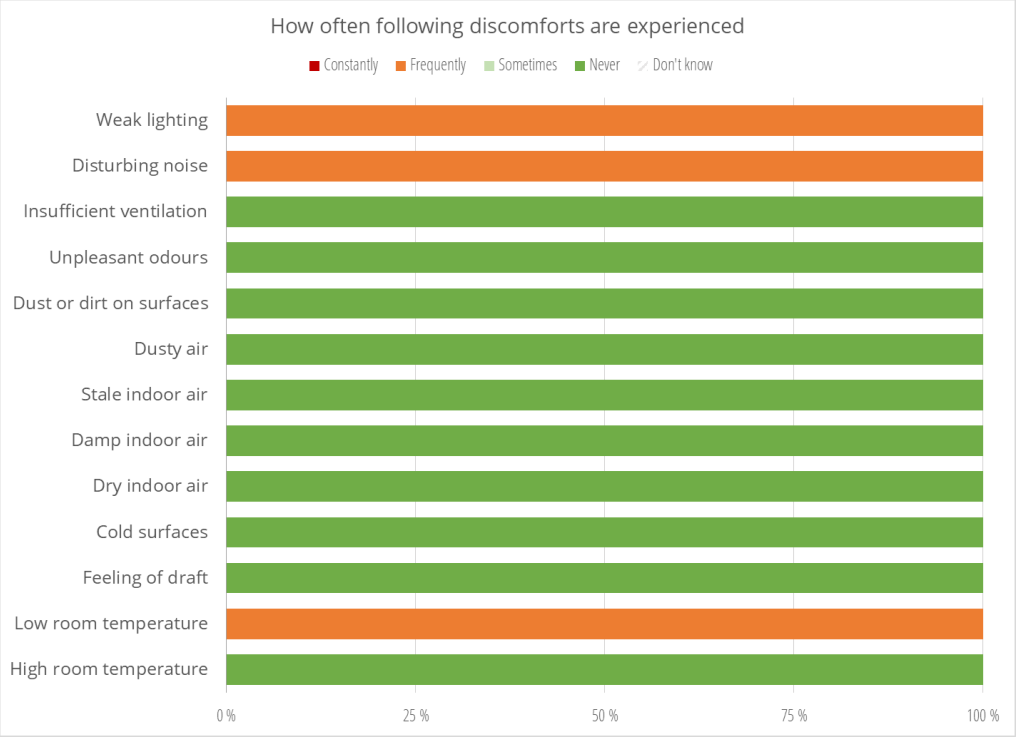


Chart 1. Results displaying how often discomforts are experienced in Wellevi pilothouse.

Conclusion

By looking at the data collected during measurement periods, the indoor climate is generally on acceptable level. For the most parts, temperature is reasonable and humidity is on a comfortable and safe level. Only possible discomforts spotted from measurement data are dry indoor air during heating season, and temporarily experienced low temperatures.

Ministry of the Environment has decreed standards for indoor air temperature. Indoor air temperature must stay within 20 – 25 °C during heating season and 20 – 27 °C outside heating season. Users did report indoor air to be cold, but no mentions of dry indoor air. Data backs up the occasional feeling of cold, which has been tackled on since the measurement periods by adjusting the heating system. During the measurement period in heating season, temperature of indoor air stayed within limits mentioned earlier. Brief peaks above 25 °C occurred, likely caused by cooking and usage of a fireplace. No high room temperatures occurred during summertime.

Indoor health code does not define exact values for relative humidity indoors. Code specifies only that humidity of indoor air must not stay longer periods on so high level that it could cause risk of microbe growth on surfaces, structures or devices. In former guides and suggestive publications, the highest safe value for relative humidity indoors has usually been 60 % RH. Code does not determine even loose guidelines for lowest allowable value, even though the fact that too dry indoor air may have negative effects on building users is widely known. No risk of mold growth due to too high relative humidity was present during measurement periods, even though values close to the suggestive limit of 60 % RH were present temporarily during summertime measurement period.

Typical problem was present during heating season: the relative humidity was very low at the times. There are no solutions to this without compromises, since adding a humidifier to ventilation or living spaces often introduces the risk of mold growth to the building and structures. Users did not report any problems with indoor health. No signs of excess moisture or water damages were noted, and measured data backs up the findings of user survey. Users did not have any health issues related to the building. Considering all data collected, it is safe to say that this pilothouse is healthy house when it comes to mold and other impurities.

Overall, the indoor climate is good, main problem being low room temperatures for prolonged periods in wintertime. Real estate management has already taken actions to eliminate the problem. Other, smaller discomforts like lighting are easily solvable, since nature of the problem is not very complex. Low energy consumption does not have negative affect on comfort of users.