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Criteria for Healthy Building

Efficient goal setting in early stages, criteria development according to best practices

Helsinki Metropolia University of Applied Sciences

Civil engineering

Sustainable building engineering

Bachelor's Thesis

1 April 2017

Helsinki Metropolia University of Applied Sciences

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Title	Criteria for Healthy Building – Efficient goal setting in early stages, criteria development according to best practices
Number of Pages	34 pages + 3 Appendices
Date	07 May 2017
Degree	Bachelor of Engineering
Degree Programme	Civil engineering
Specialisation option	Sustainable building engineering
Instructors	Jorma Säteri, Head of the Department Timo Rintala, Project Manager

This final year project was cconducted partly for a market survey and partly to be a base for the company internal Healthy Building process development. The goal for the project was to find out how the Healthy Building criteria had been used in municipal building projects. The thesis also takes look into common problems in the construction projects carried out by municipalities. The new practices, laws and regulations related to Healthy Building process were studied to recognize criteria that needed to be updated.

The project was carried out as a survey to municipalities to find out the usage of the Healthy Building criteria. After the survey, there was an option to participate in a phone interview related to the survey. The new practices, laws and regulations were studied as a literature study.

As a result, this bachelor's thesis suggests how the Healthy Building criteria should be updated. For clients and coordinators, it gives valuable information and task lists on how to start a successful Healthy Building project.

For further development, the thesis can be used to guide municipalities in their goal setting for the projects. The thesis can be used also to develop Healthy Building criteria according to the practices studied and common problems found in projects.

Keywords	Healthy Building criteria, process development, municipal sector, Indoor environment

Tekijä Otsikko Sivumäärä Aika	Petteri Salmela Terve Talo – tavotteiden asettaminen aikaisessa vaiheessa; kriteeristön kehitys 34 sivua + 3 liitettä 07 Toukokuu 2017
Tutkinto	Insinööri (AMK)
KoulutusTutkinto-ohjelma	Civil engineering
Suuntautumisvaihtoehto	Sustainable building engineering
Ohjaajat	Osaamisaluepäällikkö Jorma Säteri Projektipäällikkö Timo Rintala

Opinnäytetyö tehtiin osana markkinatutkimusta sekä yrityksen sisäisen toiminnan kehittämisen tueksi. Opinnäytetyön tavoitteena oli selvittää, millä tavoin Terve Talo kriteeristöä on käytetty kunnallisessa rakentamisessa. Yleisimpien ongelmien kartoitus oli myös osana Terve Talo -kyselyitä ja -haastatteluita. Uudet parhaat käytännöt, lait ja säädökset jotka liittyvät Terve Talo -kriteeristöön käytiin läpi. Tätä kautta tunnistettiin potentiaaliset kehitysmahdollisuudet liittyen Terve Talo -kriteeristöön.

Kunnallisen Terve Talo -kriteeristön käytön selvittämiseksi toteutettiin kysely, jonka pohjalta pidettiin tarkentavat puhelinhaastattelut. Kirjallisuusselvityksenä tehtiin uusien parhaiden käytäntöjen, lakien ja säädösten läpikäynti.

Opinnäytetyön tuloksena syntyi tieto millä tasolla ja millaisilla tavoilla kunnallisessa rakentamisessa käytetään Terve Talo -kriteeristöä. Opinnäytetyön tuloksissa käydään myös läpi, kuinka Terve Talo -mallia tulee kehittää, jotta sitä pystyttäisiin hyödyntämään aiempaa tehokkaammin. Rakennuttajille ja koordinaattoreille osoitetuissa tehtävälistoissa tehtävälistoissa käydään läpi keskeisimmät tehtävät, joihin tulee projektin alkuvaiheen aikana kiinnittää huomiota erityisesti.

Opinnäytetyötä voidaan hyödyntää jatkossa esimerkiksi kunnallisen rakentamisen kehittämiseksi ja Terve Talo -kriteeristön päivittämisen tueksi.

Avainsanat	Terve Talo -kriteeristö, kunnat, kaupungit, kehitys

Contents

Definitions

RT card – Construction related information in a compact form. The cards are created by Rakennustieto Oy in order to distribute construction related knowledge.

M1, M2 – Classification for a building material. The materials are classified according to the amount of emissioins that materials emit.

RALA – An organization that represents the real estate and construction industry.

RATU – A guide of common good practices, regarding different construction tasks.

VOC – Volatile organic compound, a harmful substance that is emitted from various building materials

1 Introduction

1.1 Background

The subject of this bachelor's thesis, the development of Healthy Building(HB) criteria, came from the company Green Building Partners Oy. Green Building Partners Oy specializes in providing environmental, energy and lifecycle services in the construction industry. The company has participated in multiple Healthy Building projects in Southern Finland. The projects have proved that there is still a need to improve the Healthy Building process to achieve better results. Completed projects show that the Healthy Building criteria should be brought to a project as early as possible to avoid any misconception between project parties.

The thesis is based on the Healthy Building(HB) criteria for office and apartment buildings [1;2]. The HB criteria were made to offer practical steps on how to reach the requirements set according to the Classification for Indoor Environment 2000 [1]. The RT cards that define the HB process were published in November 2004. Since then, the Classification for Indoor Environment has been revised. The revised Classification for Indoor Environment 2008, is still valid at the moment of creating this thesis [3], but the current plan of the Finnish Society of Indoor Air Quality and Climate is to update the Classification for Indoor Environment during 2017. After the new release of Classification for Indoor Environment, it is evident that the RT cards that are created to support the building process with practical solutions, need to be revised as well. [2.]

While the Healthy Building process has not developed after 2004, Finnish Building Regulations have moved forward. Today's building market is developing in a way that requires more and more attention to the details to construct a building that fulfills Finnish national building regulations and international energy requirements [4]. New best practices have been released after the HB criteria, and by taking these new practices into account during Healthy Building process many common problems can be avoided. [1;2.]

Some of the HB criteria do not directly apply to all types of buildings. Due to the development of Finnish building regulations, some of the criteria has become the new normal level of execution. Therefore, examining new methods and practicalities is important [1].

The thesis is carried out in cooperation with Green building partners and Metropolia University of Applied Sciences.

1.2 Goals

The first goal of this thesis is to find out how and how much the HB criteria has been used in the municipal building sector. Based on the results in the surveys and interviews, to create specific task list for a client and a coordinator to avoid most common problems related to HB criteria execution.

The second goal is to map new laws, regulations and practices to see which of them could be used to develop the HB criteria. The new methods and regulations are compared to the existing HB criteria, to see which methods and regulations could improve the HB criteria when incorporated with project. The thesis is as a basis for internal development in the Green Building Partners on how to apply the HB criteria at early phases of a building project.

1.3 Methods

Due to the diversity of the goals of the final year project. Various types of study were required. To establish some general knowledge related to HB criteria usage around Finland, a quantitative survey was concluded. Lack of responses turned the survey into phone interviews where the quantitative interview questions were discussed. Municipalities that were known to have earlier experience with the HB criteria were asked to participate in a qualitative survey. Finally interviews were concluded on the basis of the responses to the survey. The new best practices were studied through a literature study. The new methods were compared to the existing HB criteria, to recognize any additional value.

2 Current Healthy Building criteria

Healthy Building criteria aim to impact indoor environment quality according to the Classification for Indoor Environment 2008 [3]. Requirements can be divided in three main goals which are indoor environment comfortability, execution related to moisture technical functionality and cleanliness. The HB criteria are a more complete guide to achieve

good indoor air than the Finnish national building regulations. The goal for the HB criteria is to support the building process with practical steps towards comfortable indoor spaces. Healthy Building process strives to fulfill the indoor environment quality requirements that have been set according to the Classification for Indoor Environment 2008. [1.]

The Healthy Building process has six stages. The HB criteria are divided according to design areas and construction phases. From the beginning to the end, the stages are scheme design, draft design, technical design, construction phase, handover, and usage period. All phases have tasks that require attention. The requirements of the HB criteria should be incorporated in a project as early as possible. There is no template for documenting Healthy Building process. The HB criteria have some forms available for documenting certain steps of the process but these document bases do not completely cover the execution. The RT cards for Healthy Buildings, assign the responsibility for making sure that all phases are implemented according to HB criteria to the developer. [1.]

There are no authority keeping records of the projects using HB criteria, or of how the execution was carried out. According to the interviews conducted many big cities around Finland use the HB criteria to guide projects. The type of execution is highly dependent on the municipality, according to the interviews. More details about the municipal usage of the HB criteria in section 4.

2.1 Indoor air quality requirements

The Healthy Building process has multiple criteria derived from the target values for indoor environment. The criteria includes lighting design, operative temperature, indoor air emissions and acoustical performance [1]. The required values are given in the Classification for Indoor Environment 2008. The level of an indoor environment quality that is pursued will determine target values for the project [3]. The target values guide the Healthy Building process. The targets for the execution of the Healthy Building practices come from the specifications that the client has described in the call for tenders. [1.]

The implementation of indoor lighting according to the HB criteria is to be done according to the standard SFS EN 12464-1 [5]. Planning according to the standard requires that lighting fixture types need to be defined so that they fulfill the HB criteria associated to color rendering ability, glare control and sufficient light output for in the purpose. Healthy

Building process also requires paying attention to the surrounding wall colors and reflectance levels. In the Healthy Building RTcards requirements regarding lux values and unified glare ratings are set as certain values according to the space type and usage. [1.]

The Classification for Indoor Environment has three main categories. The categories are Individual indoor environment (S1) and good indoor environment (S2) and then there is the minimum satisfactory indoor environment level S3 defined in the Finnish Building Code [3]. Classification of indoor environment determines the requirements for the target values for the indoor environment such as temperature, air velocities, lighting requirements, emission requirements for various building components, and cleanliness requirements. To reach the S2 level of indoor environment, it is important to use looser dimensioning of ventilation ducts at the planning stage. This results in lower HVAC noise, as well as gives possibility to adjust the airflow rates if the occupancy density rises. The HB criteria also require temperature stability throughout the year. This can be confirmed with indoor temperature simulations in the type rooms [1]. The HB criteria also require that the acoustical design of the building HVAC system is done according to the standard SFS 5907. [6.]

The HB criteria require the use of building materials specified according to M1 or M2 level material requirements. Emission goals are set for the ventilation system parts and materials inside the building shell. The materials used can be checked from the online library that Rakennustieto manages, to ensure that the materials qualify for the M1 classification [7]. To ensure a high quality result, it is also important to pay attention to the handover stage to possible furniture emissions. The HB criteria requirements for furniture consist of fulfilling the M1 classification. This is ensured by using materials of the M1 category. [1.]

2.2 Moisture

The main goal is to avoid moisture problems by providing functional structures. First of all, the level of the required structural design tasks is determined. To determine the level of structural design tasks, the project details are evaluated. Space types, structural solutions and bearing load capacity are a part of the evaluation. To avoid problems related to a moisture technical functionality in the project, all structural solutions are analyzed. This analysis covers all structure types in the building envelope and it needs to be done

during the draft design stage. The timing of the structural analysis is critical so that it is still possible to impact the solutions implemented in the project. [1.]

Once the main structural solutions, such as the walls and roof, have been checked, it is required that all the execution details are updated for the worksite. These details should cover all moisture technical details such as moisture barrier continuity. The structural details related to airtightness of the building, such as structural inlets through the slab. To ensure the functionality of the structures during the usage period, there must be a service manual with details about the structures that need to be observed. [1.]

On the worksite, problems associated with moisture contol planning are to be taken into account. In practice this means that the timetable is checked to match the drying times of concrete structures. To ensure that all critical structures on the worksite are dry all surfaces that are to be covered need to be measured before the coating layers are installed. [1.]

2.3 Cleanliness

At the beginning of the process, the cleanliness level for the ventilation system and requirements for construction works are set according to the P1 level of cleanliness. In practice this requires timetable planning and detailed requirements for P1 level cleanliness documents associated to planned execution. All steps are described in the project boundary contract which also states the name of the person responsible for the execution. [1.]

Before the building stage, the project contractor creates a specific P1 level dust control plan. To ensure that any task with an effect on cleanliness is carried out according to the P1 requirements, the methods for documenting and measuring the tasks must be defined before project is begun. For ventilation cleanliness requirements, it is necessary to assign an individual in charge for the inspection of ventilation system cleanliness before any test runs. These details need to be solved before the construction begins. [1.]

It is the Contractor’s responsibility to carry out measures according to the P1 cleanliness during the building stage. This means creating cleanliness zones in accordance with HB criteria, this is done by zoning walls from spaces with different level of cleanliness. The

HVAC installation requirements mean that the installations should be done in the “vacuum level” of cleanliness. When certain building zone is divided and isolated according to P1 requirements it is not allowed to carry out any work that produces dust without proper equipment. [1.]

3 The state of Finnish educational buildings

3.1 Overview

The Finnish parliament concluded a study into the condition of public properties in the year 2012. In this study, it was seen that the building types most prone to have moisture problems are educational buildings and institutions. Of municipal educational buildings, 12-18% have at least some moisture problems. Half of the principals informed that they have some indoor air problems. Roughly half of the indoor air problems are caused by moisture problems, but there are also other reasons that decrease the indoor environment quality. [8.]

Table 1. Significant moisture problems associated to building type. [8]

Building type	Percentage of significant moisture problems
Row houses	7 - 10%
Multistory houses	6 - 9%
School and daycare	12 - 18%
Institution	20 - 26%
Office buildings	3 - 5%

These moisture and mold problems are mostly caused by the building process itself. Four out of five problems are due to poor quality of structural details or critical mistakes during the construction phase. The rest of the problems are due to maintenance mistakes or ignorance towards seasonal upkeep routines. [8.]

3.2 During design stage

The moisture problems revealed in the study were usually caused by external moisture sources. In the studied educational buildings, two main building components that were

most prone to moisture problems were roof structures and ground floor structures during the construction stage. The next most volatile structures were wall structures and upper floor structures. The upper floor structures were harmed by a combination of rain, snow and wind. Ground floor problems were caused by capillary rise from the ground because of construction errors or lack of attention to details. [8.]

A major cause for the problems in the studied educational buildings was that the envelope structure was not airtight in the moisture barrier area close to inlets. Due to air leaks in the moisture barrier, condensation was a problem inside the wall structures [8]. To ensure a good level of execution structural designer has to provide worksite with details related to the moisture barrier continuity. This is one of the key methods to make sure there is no air leakage through building envelope joints. [9.]

3.3 During construction stage

Numerous reasons cause indoor environment quality problems found today in public buildings around Finland today. Construction phase problems that are presented below can be addressed directly by adopting Healthy Building practices at the project planning and during construction. [8.]

The structural solutions that cause problems for building envelope are mainly details of the foundation and roof solutions. When attention to the details of the foundation and roof solutions were executed in wrong way it resulted in external moisture sources penetrating to structures. This external moisture then produced indoor air quality problems and a mold. Moisture entering the structures came from capillary water rising, condensation and rainwater flow surfaces. [8.]

Poor weather protection during construction stage resulted in a moisture problems faced in educational buildings. According to the study, more attention should be paid to weather protection during the construction phase. Problems with HVAC consist of dirt and dust in the ductwork. [8.]

The contractor’s lack of knowledge was one of the reasons for the poor execution of details during the building process. Lack of sufficient knowledge does not come from the contractor side alone, but also designers working with details need to have more knowledge about moisture and mold problems. [8.]

3.4 During usage period

According to a study carried out by the Finnish parliament, one in every five mold and moisture problems arise from incorrect maintenance or a lack of maintenance. To find moisture problems before they grow too big best way is to investigate the condition of a building every few years and spot problems early on when they can be still fixed with a small effort and investment. A lack of a proper maintenance strategy and seasonal maintenance tasks were often a problem. In the public sector, maintenance was usually neglected because of a lack of funds closer to the end of a buildings life cycle. [8.]

To be able to efficiently spread the knowledge from builder to occupant, it is important to create precise a building specific maintenance strategy. The strategy has to be discussed through with the maintenance team and building occupants so they have all necessary knowledge required to run the building properly [9]. According to study regarding Finnish daycare buildings, building users lacked a simple guide on how to operate the ventilation and temperature controls in the building. Instructions regarding the procedure when indoor air problems arise were not clearly known with occupants. [10.]

Several Finnish universities conducted a study on the indoor environment quality in daycare facilities. It was seen that the ventilation was properly sized when the daycare buildings were constructed, but due to an increase in group sizes it was not possible to guarantee the necessary quality. Lower outdoor airflow rates with higher population densities cause inferior indoor air especially in areas with long periods of high density of people in the same room. [10.]

4 Interviews

4.1 Process

The interviews for this thesis were carried out during December 2016 and January 2017. The interviews kept based on the surveys regarding the HB criteria. The survey questions and results are shown in the Appendices 1 and 2. The qualitative survey was concluded to the municipalities that were known to have earlier knowledge with Healthy Building practices. The quantitative survey was concluded to municipalities who usage

of Healthy Building practice was unknown. The interviewed parties can be seen in Appendix 1.

The results of the interviews are rounded up in chapter 4.2. In order to find out how municipalities were using HB criteria, the following procedures were carried out:

- Qualitative and Quantitative survey for municipalities
- Seventeen phone interviews related to Healthy Building survey
- Participants for the survey were from municipalities, contractors and coordinators.

To establish the contractor's point of view of the contractor, worksite foremen and coordinators were interviewed. Individuals who were interviewed were known to have experience of Healthy Building process execution. The main problems and development needs from the interviews were taken as a part of this thesis and as a base for the development of the Healthy Building criteria and process.

4.2 Results of the surveys and interviews

According to the interviews the execution, of the HB criteria was very different from one respondent to another, as can also be noted in the surveys carried out. According to the interviews, the most common problems were related to a lack of proper documentation and moisture technical functionalty. Some of the respondents used HB coordinators to lead the process. They had the best results as it comes to the execution and documentation of the criteria.

The municipalities that have used HB criteria as part of their building process have mainly started using the criteria after year 2010, according to the interviews carried out. The HB criteria have been used in many different types of municipal building projects. The usage of the criteria was included in educational buildings, many of the healthcare buildings, and some sports halls and swimming halls. The survey showed that mostly used HB criteria were related to emissions, target values for indoor environment and work site cleanliness requirements. According to interviews type of weather protection ranged from requiring a tent to a sheltering structure as a scaffolding.

The interviews that were carried out showed that the execution of the criteria was highly dependent on the municipality. To give an example two different types of execution are

described next. These two types are low level execution and high level execution. In the low level execution of the HB criteria there was only some moisture and cleanliness related criteria specified. This low level execution also trusted to ethics of individual designers to carry out all the required criteria. This type of execution did not have person responsible and the process was not documented. At the low level execution criteria was usually only bound to construction stage.

High level of execution according to the interviews. This type of execution contained usually all of the HB criteria set out in the RT cards. In high level of execution, a person was appointed to be responsible for documentation of the process. The person is in charge of going through the details with designers in meetings, checking plans, and validating the end result. The high level of execution took all criteria into account at the design stage to make execution suitable for the builder to execute the building process according to HB criteria.

The need for a third party Healthy Building coordinator was seen necessary in half of the municipalities interviewed. In this half, two types of interest towards the fulfillment of the HB criteria documentation and project guidance was found. One group recognized the need to improve or make their Healthy Building approach wider by taking more HB criteria related requirements into account. Another group did not want any coordinator to the client side but saw it necessary for the contractor to have a coordinator to ensure the process to be executed with high quality. In the other half of the municipalities interviewed people did not see a reason to take an other coordinator for the process. These were generally smaller municipalities working with same designers for a long time with less repeatability in their process.

According to the respondent’s HB criteria has been well met in the projects. Justifying the actual fulfillment of the criteria and comparing results between municipalities is not possible because lack of a complete documentation. Biggest challenges have been related to moisture technical functionality and drying times. Most challenging individual requirements have related to moisture physical functionality. According to interviews typical reason for the criteria not being met was a lack of detailed goal setting according to the HB criteria. Practical implementation requirements were not described in enough detail in contracts, and there was a lack of communication between designers and the contractor.

The interviews revealed common problems according that lead to poor HB criteria execution:

- There is no appointed person in charge
- HB criteria were not present from the beginning of the design process
- Lack of communication between project parties
- Specifications of the criteria were not detailed enough in the contracts
- Confirming measures were not described in the contracts

Parties that were interviewed were contractors, municipalities as clients, and a coordinator from a company offering Healthy Building coordination services. People interviewed and the questions that were discussed with them can be seen in detail in appendix 3.

4.3 Client

According to the interviews concluded with municipalities, the client saw the Healthy Building process as a positive development in the municipal construction process. For larger municipalities, it was easier to appoint a coordinator to be in charge. In smaller municipalities, the HB criteria suitable for a project were set as targets for designers.

From the client's point of view, several problems were listed during the interviews. The clients saw the S2 requirements as too strict, especially for school buildings which are usually built without cooling and, therefore, it is not possible to meet the requirements during the summer time. According to larger municipalities, there is a lack of documentation guidance for the execution of HB criteria. Also from the client's point of view, the coordinator’s job was often just confirming the fulfilment of the criteria. Larger municipalities would like to see more guidance for constructors from the Healthy Building coordinator.

The problems that the clients mentioned:

- Timetable problems regarding drying and cleaning time reserved for project
- Lack of Healthy Building guidance and steering of design process
- Smaller contractors do not have enough knowledge regarding Healthy Building process
- Moisture problems with delta beams, floor surface materials and thick concrete structures for example air raid shelters

- Individual problems with air handling unit silencers, and some M1 material problems when combining two or more M1 class materials

4.4 Contractor

Contractor's site foremen were interviewed. According to the interviews, HB criteria implementation has been implemented with very little resistance in the field. A building site that implements the Healthy Building process according to the P1 level requirements results as a cleaner worksite and most employees prefer working on these sites. According to the foremen interviewed, a construction site that takes HB criteria into account requires more planning and work. For a successful project, it is important that the requirements are set during the draft design stage. Only then it is feasible for the contractor to take all the implementation details into account, and many misunderstandings can be avoided.

Implementing the HB criteria increases the building costs between 3-5% according to the interviews and earlier studies [11]. Weather protection, which is already mandatory in many cases, is included in the costs so the true cost is even smaller. The cost of weather protection is also highly dependent on the building type. In educational buildings weather protection affects the price a lot because there is a large coverable area. Most of the costs associated with HB criteria implementation can be recognized during the planning phase, but costs will be realized during the building process. More workforce is required on the construction site to carry out the needed cleaning and zoning tasks. Cleaning demand on the project is larger during the construction phase and lighter during the final cleaning up compared to project without HB criteria.

Worksite foremen described certain common challenges encountered during construction. For a successful project execution, it is important that the client knows beforehand exactly what they want from the project. When a client knows the details of the execution the contractor is to fulfill, it is a lot easier to discuss the execution. When a client is uncertain or has not specified how the implementation is to be done clearly enough, it usually results in unexpected budget and timetable changes. Drying of concrete structures caused timetable challenges during the construction process. To overcome these challenges drying time calculation and drying conditions are to be defined. Moisture technically challenging details have to be defined during design phase so that it is well known how to execute structures that are prone to moisture problems.

4.5 Coordinator

According to the interview with the Healthy Building coordinator, there has been a clear increase in the number of projects including HB criteria in project execution. The usage of the criteria has started to increase lately, because increased of knowledge about the HB criteria in municipalities has risen. It is allways client who defines that a project must be executed according to HB criteria. Some of the municipalities have adopted Healthy Building procedure as a part of their building protocol. For a coordinator, it is important to be involved in the project as early as possible to be able to have an impact on the structural details in the building process. For a successful project, it is important that the client sets requirements according to HB criteria and discuss the set goals with the contractor. If the client is not familiar with the requirements or lacks knowledge, it would be better to use a third party coordinator. Healthy Building coordination is not in the reach of all the smaller companies because it requires knowledge about multiple design areas.

There is a need to develop the criteria to a direction where steers coordinator to use latest standards and best practices, according to the interview with HB the coordinator. The most important individual measure is to use a third party to check moisture physical functionality of the structural solutions to avoid moisture problems within the structure. The HB criteria have details overlapping the requirements with HVAC related RT cards. From coordinators perspective, HB criteria should be improved in the way so that it directs the user to the specific RT cards to be used for the details associated with HVAC systems.

5 Changes in requirements relating to Healthy Building criteria

This chapter introduces the findings of a literature study. This chapter consist of Changes in requirements related to the Healthy Building criteria. New or updated requirements, laws, publications and tools are presented in this chapter.

5.1 Building indoor climate and ventilation regulation

Section D2 is the part of the Finnish National Building Code that lists the legal requirements for indoor environment and ventilation. The latest version of D2 was released 2011

and it has been in effect since the year 2012. It replaced the 2008 version of D2 regulations. [12.]

Section D2 compares to the Indoor air climate class S3, the minimum requirements in Finland. Some of the D2 requirements are allready in line with the better indoor air quality class S2 already because HB criteria has not been updated after new D2 releases [1]. There are some overlapping requirements in D2 and the HB criteria, such as the requirements for HVAC filtration and material requirements. In the building regulations, the guidance for material storages and qualities are not specified as precisely as in HB criteria. According to D2 Acoustical specification for building are set according to SFS 5907 standard class which is same as in HB criteria. [6.]

Worksite requirements of the section D2 are in line with the HB criteria but the HB criteria goes more in the details related to construction process, while D2 is more like a general guide. The D2 specifies material storage and covering ventilation installations during the building stage in the same way as the HB criteria. D2 sets general requirement for ventilation system cleanliness examination and cleaning but it does not address to use any certain type of investigation. There is no specific way pointed out how the examination should be done which can be very problematic if not discussed between client and contractor. [12.]

Section D2 of the Finnish National Building Code specifies on the general level the same requirements as the HB criteria do much more in depth. Specifying the requirements just according to the D2 leaves a lot more room for different levels of execution. By using the HB criteria instead of the D2, much clearer goals can be set in the early phases of the project. [12.] Definitions are much vaguer in the D2 than in the HB criteria [1].

5.2 Declaration about plans and report requirements in construction project

The Ministry of the Environment has released new guidelines for the building plans and reports. The publication covers the requirements for composing plans for controlling moisture on a worksite. The plan has to cover measures to be taken to protect structural components, materials and products from moisture. In practice, this means that the plan has to define precise weather protection for the transportation, installation and storage of components. The declaration of the Ministry of Environment also defines that the structural moisture must be measured prior to installing any covering layers on surfaces. [13.]

Some of the regulations in the declaration are similar to those defined by HB process. Therefore, they could be erased from the HB criteria or alternatively pointed out to be carried according to the declaration. [1;13.]

5.3 Classification for Indoor Environment 2008

The latest Classification for Indoor Environment was published in the year 2008 by the Finnish Society of Indoor Air Quality and Climate. The classification describes quality solutions that can be implemented to achieve better indoor quality than with the regular building code regulations. The classification helps in the goal setting, and lines up criteria to get better indoor environment quality in building projects nationally. The Classification for Indoor Environment sets higher requirements for construction than just the bare minimum required by national standards. [3.]

The Classification for Indoor Environment has three classes, S1, S2 and S3. The highest level of interpretation is S1, while S3 represents the bare minimum required by the Finnish legislation. [12.] The differences between the classes are in the operation temperatures, level of user control, carbon dioxide levels, acoustical performance, lighting control and air filtration classes. The Classification for Indoor Environment 2008 lines out the requirements set for a project as measurable values and quantities. These values differ between the three indoor environment quality classes. The classification for the indoor environment is done according to the three core values set for a project. The core values are indoor environment quality class, construction work cleanliness requirements and emission requirements for the building project. Measurable values for the indoor environment quality that have to be stated in the contract documents are listed down below. [3.]

- Operative temperature (°C)
- Air velocity (m/s)
- Dimensioning airflow (dm3/s, dm3/person)
- HVAC sound pressure levels (dB)
- Weighted normalized impact sound pressure levels (dB)
- Sound pressure level of external sources (dB)
- Lighting intensity, glare index and color reproducing index (lux, UGR, Ra)
- Emission concentration levels (Bq/m^3, ppm)

- Material emission requirements (M1)
- Construction work site cleanliness (P1)

For a building project to be able to meet, the criteria attention must be paid to details in each design area. Practical measures to meet these criteria are given in HB criteria, see chapter 2 above. [3.]

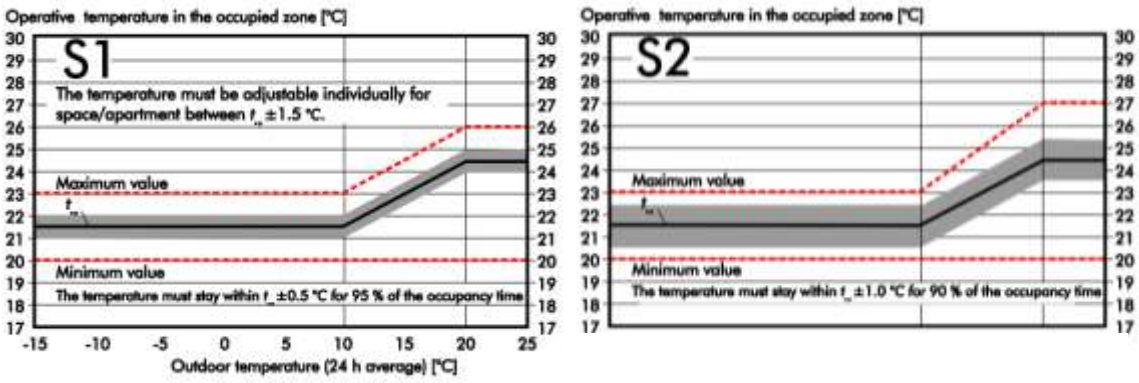

Figure 2, Indoor temperature according to Classification for indoor environment 2008. [3]

To meet the requirements for indoor environment quality, material emissions and internal pollutant sources such as building materials, must be taken into account. The indoor environment quality categories specify allowed levels for the sources of the air pollutants. The substances that are regulated are ammonia, formaldehyde, volatile organic compounds, carbon dioxide, carbon monoxide, ozone and radon. The values for material emissions from building materials installed inside the moisture barrier have been similar since the Classification for Indoor Environment 2000. According to the classification, all permanent materials in a building must be M1 class products, with the exception that a building can have a maximum of 20% of M2 categorized materials [3]. All materials that fulfill the classification are listed by Rakennustieto, an organization for the distribution of valid knowledge about building construction. [7.]

The acoustical requirements for a building are given in the SFS 5907 standard [6]. The acoustical standard, has four different performance categories A, B, C and D. Class C represents the minimum values of the building code and category D is used only for assessing old buildings. There are different acoustical requirements for different types of buildings. The SFS 5907 standard covers the required values for sound pressure levels, reverberation times and ventilation system sound pressure levels. The indoor environment quality class S2 sets acoustical requirements at level C, the minimum level of

acoustical performance according to section D2 of Finnish Building Code [12]. The category S1 is primarily pursues acoustical values in category B which is slightly more demanding than category C. Acoustical confirmation measurements can be done additionally according to national standards to confirm criteria met after building project is completed. [3.]

Lighting solutions are to be made according to the standard SFS EN 12464-1 [5]. SFS EN 12464-1 is the standard for the designing lighting solutions indoors. Lighting design carried out is similar for Indoor air quality categories S1 and S2. The only addition that the category S1 has over the category S2 is requirement for individual workstation lighting control. The lighting design according to SFS standard values to be defined are lighting illuminance intensity and uniformity, united glare index, and color rendering ability. Lighting levels can be measured according to the SFS standard. [3.]

5.4 Moisture control portal

The moisture control portal has been made to guide individual house builders in Finland. The content of the website kosteudenhallinta.fi is created by Mittaviiva Oy in cooperation with the Ministry of Environment, Rakennusteollisuus, and Technical University of Tampere. The website has been created to inform the parties about their moisture technical planning and execution tasks. The website has gathered data from various publications that guide the moisture technical planning. The website offers a possibility to tackle moisture problems from four different directions, that is moisture problems during different building stages, responsibilities of the parties, structural details, and actions to meet the set requirements. For example, website incorporated task lists for every building component and different types of structures used in buildings. The main structural categories are foundation and substructures, mid floor structures, roof structures, external walls, moisture wise demanding spaces and details about moisture barrier continuity. All main categories feature subcategories as well as give detailed instructions about every individual structure. [14.]

The Process of Kosteudenhallinta.fi is based on a risk analysis that has three risk categories R1, R2 and R3. The risk categories and typical buildings in these categories are shown in table 2 on next page. According to the risk category that is specified for the building, different types of tasks are required from the moisture technical planning process. The execution process categories for the building project are defined below. [14.]

Description	Risk level	Building types
Low risk	R1	Conventional structures (office, residential and commercial buildings)
Normal risk	R2	More demanding conventional structures (daycare, schools, office, residential and commercial buildings)
High risk	R3	Highly demanding structures (swimming hall and cold storages)

Table 2, Moisture risk levels according to kosteudenhallinta.fi. [14]

The execution of buildings that belong to category R1 – low moisture risk is done by a checklist provided by kosteudenhallinta.fi. The checklist covers for example foundation moisture management, keeping building shell dry, wet space solutions, technical solutions, construction site circumstance control and maintenance period requirements. The designer informs the contractor about the solutions and specifies products used for insulation, wet space products and water barrier. After choosing the products that are going to be used, it is also required that the structural designer draws the details to cover moisture technical solutions of the building envelope. These details should show how the moisture barrier continuity is built, and how and where waterproofing membranes are installed. The building contractor is in charge of creating a moisture safety plan for the construction time as well as for creating usage and maintenance guide for the building user according to the instruction on the site kosteudenhallinta.fi. [14.]

The execution of a building in class R2 (Normal moisture risks) requires the same procedures as a building in class R1. As addition, individual structural component risks are analyzed. Also, it is required to carry out an investigation for each structural solution that has moisture loads to check condensation point, drying time estimations, and accumulation of moisture throughout the yearly cycle. Similarly to R1 requirements, the designer must draw moisture technical details for each of the analyzed structures. The procedures are to be done whenever there is a moisture risk present in the structure. To define the risks, kosteudenhallinta.fi provides further instructions. [14.]

The Highest moisture risk class – R3 execution includes all the procedures from the earlier classes R1 and R2. Also, when building according to R3, more detailed analysis regarding a structural and physical analysis of the structures are required. All structure

types that are going to be used must be checked to recognize potential risks. Nonstationary calculations and analyses must be carried out when structure has potential moisture risk. All new types of structural solutions and technical systems have to be analyzed in laboratory conditions before implementation. All critical structural and technical solutions must have detailed usage, maintenance and replacement schedule. [14.]

Details from the site kosteudenhallinta.fi would certainly benefit a building project to minimize problems related to a buildings moisture technical functionality. It has a collection of relevant information about best practices available today, and it shows actual building details in depth unlike for example Dry Chain 10. More details about Dry Chain 10 process see chapter 5.5 below. Execution according to the site kosteudenhallinta.fi would be a lighter approach than Dry Chain 10. Therefore, it could be used in smaller projects that prefer a lighter execution[14;15.]. When compared to the HB criteria kosteudenhallinta.fi offers wider and more in depth approach for analyzing moisture technical solutions, and guidance how to carry out a proper risk analysis for a different type of structures. [1.]

5.5 Dry Chain 10

Dry Chain 10 is a new process model for controlling the moisture challenges of a building project by addressing the 10 major problems that are most typically present in moisture damaged buildings today. Dry Chain 10 was developed by the municipality of Oulu to avoid most moisture risks in buildings. Dry Chain 10 aims to lower of additional costs associated to poor moisture technical solutions during the building project. Every detail is significant, missing just one affects the whole outcome. The requirements determined for Dry Chain 10 take into account moisture risks throughout a buildings life cycle from cradle to grave. Dry Chain 10 has checklists that have tasks listed for each project party. The checklists are also used to document the Dry Chain 10 process. Dry Chain 10 process analyzes risks in a building project depending on building type, construction place, architectural details, structural solutions and material choices. [15.]

Dry Chain 10 implementation starts by choosing a qualified moisture coordinator for the project. In practice, this means that the coordinator should have an education according to the structural difficulty of the building. The classes of Dry Chain 10 are ordinary, demanding and exceptionally demanding. The classes are based on a Finnish government declaration that defines the difficulty levels in building construction [16]. The moisture

coordinator should be responsible for carrying out the project according to Dry Chain 10 from the beginning to the handover. Only in the case of force majoure it is possible to change the coordinator during the building process. [15.]

It is the responsibility of the moisture coordinator to oversee that the building project is executed in accordance with the Dry Chain 10. The moisture coordinator approves or disapproves all solutions that designers create. The moisture coordinator's job is to make sure that all the design criteria are met and to document execution according to the Dry Chain 10 process. The moisture coordinator plays a major role in the succesful project. The moisture coordinator makes sure that all the details that are decided upon during the design stage are implemented during the construction stage. To make sure all the solutions of the designers are feasible, all details are discussed in meetings with the moisture coordinator, designer and contractor. [15.]

Dry Chain 10 process also features in depth excel sheets, ready to use for the documentation of all the necessary details of the project. The excel tool comes pre filled with responsibilities of each party which makes the documentation even more user friendly. As the person responsible of moisture risks, the coordinator is to make sure that all the details are taken into account. [15.]

A project that is carried out according to the Dry Chain 10 guidance and is appropriately documented can apply for a Dry Chain 10 status. If the status is going to be applied for the project must be reported to RALA at the ordering stage at the latest. After this the moisture coordinator is responsible for documentation and reporting the process to RALA after each stage of the project. [15.]

Many of the HB criteria overlap with those of the Dry Chain 10. Adding the Dry Chain 10 process to the HB criteria would add value because it gives more direct guidance about the details to take into account. The HB criteria alone are not as specified as Dry Chain 10 on the detail level. By doing moisture coordination according to the Dry Chain 10 process would improve the level of documentation and would bring consistency and comparable results. [1;15.]

Problems covered by Dry Chain 10 that are not present in the HB criteria:

- Appointing a moisture coordinator to be responsible for the moisture technical solutions

- Directing rainwater out of the building shell beneath the first cladding
- Driving air handling units in wet spaces by moisture sensor data
- Water piping hydrostatic tests and installing them inside a secure tube that guides water to a drainage area in case of a leak
- Strict values for example yard inclination angle
- Practical methods to check details during the process

5.6 Environmental tool by Rakennustieto

December 2016 Rakennustieto announced in RT ympäristötyökalu [17] a national environmental rating tool that has similar qualities as the more commercial LEED and BREEAM [18;19]. The tool replaced the old national building certification system PromisE. PromisE was released on in the early 21th century and it was not easily updatable [20]. The goals for the project by Rakennustieto were to increase user satisfaction in the buildings by using good solutions in lighting, acoustics, innovative space design and solutions to support clean indoor air. For a user, the tool requires effective space design, lowered moisture risks in structural solutions, lower energy and maintenance costs, and higher rental income. [17.]

The classification process of a building follows a four step path. The first step is to get the environmental rating tool for the project by completing a fee. After this, the user sets goals and potential criteria to reach. The criteria are divided to 5 main categories, process, economy, environment and energy, indoor air quality and health, and innovations. The main categories are weighted differently according to their requirements. The process is split into three stages which are to be completed during the design phase, building phase and usage phase. [17.]

When the Environmental rating tool is compared to the HB criteria, many similar requirements can be found. The Environmental rating tool has taken moisture technical guidance from the Dry Chain 10 and the moisture control portal. The environmental rating tool gathered the most important individual tasks under the tools criteria [15]. In the Environmental rating tool, there are two criteria that include moisture technical requirements. One for the planning phase and another for the construction. Other important publications have also been part of creating the Environmental rating tool such as Concrete drying measuring RT14-10984 [21], TKK publication to guide structural temperature and moisture planning. [24.]

The worksite time execution practices in the RT Environmental tool were defined according to the indoor air classification 2008 [3], RT 07-10805 [1], Cleanliness at a construction site RT 91-10970 [27] and Dust control at a construction Ratu 1225-S [22]. The requirements guide execution and construction site cleanliness plan which is required. HVAC works is to be carried out on cleanliness level P1, for HVAC system a visual inspection is required prior to starting the system. The visual inspection is a mandatory and additionally dust levels can be measured with methods approved by Indoor air quality classification. [3;17.]

Indoor environment quality requirements are based on Indoor air quality classification 2008. In the criteria that have been done for RT – Environmental tool are being modified slightly from the Indoor air quality classification. The difference between Environmental tool and Indoor air quality classification 2008 is that Environmental tool aims directly to demand based ventilation that is controlled by the Co^2 sensor data. The requirement for user controls must be available in every space, but these controls should be limited from house automation so that user cannot set for example heating completely off. To ensure pure indoor environment quality, only the use of categorized materials such as M1 is allowed. Apart from M1 classification, there are other material labels that are approved as well, such as Emicode EC1 and Blue angel [25;26]. Like other process defining models, Environmental tool model also features optional indoor VOC measurements to ensure high quality of indoor air.

Environmental tool defines acoustics to be built according to the standard SFS 5907 [6]. Further details about the standard can be read in chapter 5.7. Open space offices are to fulfill the sound measurements in the standard SFS EN ISO 3382 [23]. In the HB criteria, there are ways to implement proper acoustical design for an HVAC system but not for room acoustics.

5.7 Acoustics

The Healthy Building criteria do not set any requirements for acoustics. Indoor air quality classification requires acoustical planning to be carried out according to the standard SFS 5907 [3]. The standard is comprehensive in determining the acoustical performance for various space types, for example offices, apartments, schools and daycare buildings. The acoustical requirements are divided in four classes which are A, B, C and D. Of

these classes, A represents the highest quality and C is similar to minimum requirements in the Finnish National Building Code [28]. The acoustical class D applies only to old buildings, it is not used in the new buildings. [6.]

A process carried out according to the standard SFS 5907 determines required the acoustical performance from different sound types present in the building. The standard sets limits for different sound types, which are both airborne and impact sound pressure levels, and for technical appliances such as heating and ventilation. In the standard SFS 5907 acoustical requirements set for the technical components of a house take into account both internal and external noise levels. The acoustical requirements for rooms apply for furnished spaces. To determine the acoustical performance class, reverberation times, speech transmission index, airborne sound insulation, and impact sound insulation are assessed. [6.]

Noise is generated by different octave bands and therefore each band is assessed separately. To determine the correct amount of absorption material, the octave bands 125, 250, 500, 1000, 2000 and 4000Hz are assessed. After this, absorption material that needs to be added to meet the requirements of the relevant building type can be calculated. Calculation details are provided in the Appendices of the standard SFS 5907. [6.]

For school buildings, there are no specific requirements for open study spaces that are often built in school buildings today [6]. The Healthy Building process does not directly require any acoustical measurements to be carried out [1]. That should be added in the HB criteria. The importance of acoustical functionality is especially important in school buildings were good acoustical performance allows effective learning, in a good quality environment. [29.]

5.8 Site cleanliness

According to the construction site cleanliness development option study done by the cleanliness coordinator Tarja Andersson of TPA Andersson, P1 level requirements set according to the Classification for Indoor Environment are generally well met [3]. The development between the years 2013 and 2015 has been positive, and surface dust levels decreased. Surface dust measurements have met the requirements of the Classification for Indoor Environment . When cleanliness requirements were not met, the prob-

lem was individual high dust concentrations. For dust measurements that TPA Andersson has done there is no difference between renovation and new construction projects. [30.]

To improve the P1 classification, TPA Andersson suggests more practical steps to guide the planning of the cleaning process. Dust inside a ventilation system should be measured with a BM dust detector instead of the filter method which is outdated [31;32]. The requirements for the inside and outside dust levels of a ventilation system are contradictory. The inside dust level value is specified to be 8% whereas the surface dust level outside the ventilation channels above the suspended ceiling is 5%. This means that the system can be dirtier inside than outside. [30.]

6 Starting a successful Healthy Building project

This chapter was written to give guidance to the client and coordinator of a Healthy Building project. In this chapter requirements for client goal setting, coordinators tasks, and setting requirements for constructor during the early phases of the project are explained.

6.1 Setting efficient goals in concept design stage

When starting a Healthy Building project there are important details to consider at the various stages of the project. First at the concept design stage, the goals of the project must be clearly defined. To set specific goals for a construction project, it is vital that the client knows what they are after. When a client is not sure about what level of Healthy Building aspects are necessary for the project, it is hard for bidders calculate all the undefined requirements that are not stated clearly. This uncertainty in the executions is often the cause of problems further in the project when trying to find solutions that would satisfy both parties. It is important to remember that HB criteria are binding for both parties the way that they are specified in the contracts [1;3]. Because each project is different regarding execution and criteria to considered, and experienced coordinator can be extremely beneficial for the project.

When it comes to the Healthy Building process, the client should be able to determine at least the following values that affect to costs of the project: indoor environment quality class, indoor temperature levels, indoor environment quality values, acoustical performance requirements, lighting requirements, air velocities, construction and ventilation

work cleanliness class and furnishing requirements [1;3]. It is important to recognize the exceptions and additions to be taken into account for the solutions in a moisture technical planning and heating systems. This could be details about weather proofing, moisture measurement plan, following drying conditions of the structures, and specific material storage requirements. If for some reason the client is not sure about how to determine values for these criteria, it is better that they use a coordinator to set the requirements for the project as early as possible.

When the goals are properly set at the beginning, they guide the construction project in the right way and result in less of a trouble later when the project moves to the next stages. A successful project always starts from planning and it lasts all the way until the end of the buildings life cycle. Having a coordinator that is solely responsible for bringing Healthy Building topics on the table eases the process significantly. At the draft design stage, it is also important to address the measures that are taken to ensure meeting the criteria. This can mean for example requiring P1 cleanliness confirmation in the form of a surface dust measurements and visual inspections.

Standards and guides have many different categories of implementation. The client must be familiar with the standards and make sure that all the following values are specified accordingly. When all the details and exceptions are specified it allows a contractor to give more precise price estimation.
Check list for values Defining goals for a project:

- Indoor air quality requirements according to Indoor air quality classification (S1, S2)
    - Defining possible allowed exceptions in following values:
    - Thermal environment target values (°C)
    - Air velocity requirements (m/s)
    - Indoor air quality requirements (ppm, Bq/m³)
    - Air volume dimensioning requirements
    - Defining allowed exceptions for example schools do not have to fill temperature limits during summer months.
- Lighting target values according to SFS 12464-1
    - Illuminance (lux)
    - Color reproducing index (Ra)
- Acoustical target values according to SFS 5907
    - Sound insulation target values for all noise types (dB)

- Emission requirements
    - Construction material emission class (M1)
    - Furniture emission class (M1)
    - HVAC products cleanliness level (M1)
    - Furniture and indoor structure requirements according to (M1)
- Structural design requirement class
- Preset value definitions for HVAC systems, as well as measures for testing and acceptance of HVAC system

Recognizing additional requirements to HB criteria:

- Physical study for moisture in
    - Foundation structures
    - Wall and roof structures
- Appointment of coordinators responsible for HB criteria and Dry Chain 10 implementation and documentation
- Temperature space simulations to recognize needed measures to meet specified indoor air quality class (S1 or S2)
- Technical examination of moisture for structural solutions
- Appointment of an acoustician to verify the fulfillment of standard SFS 5907
- Analysis of building zone soil and runoff waters

6.2 Requirements for draft design stage

In the draft design stage, all goals should be set and it is time to discuss the execution and practical measures that are necessary to meet the requirements set earlier [1]. It is important to organize a meeting about to the execution of the HB criteria and to recognize any challenges to be expected in the construction process. At this stage, there is still a lot that can impact the final solutions. In a meeting with designers all HB criteria that are going to be implemented should be discussed throughly. The Healthy Building coordinator is the right person to lead the meeting and to raise the critical details to the open discussion about implementation. As a result from the meeting, the Healthy Building coordinator compiles task list for each designer about the details that they have to take into account in their work.

During the draft design stage, decisions are made about many details that affect worksite execution. Because of this fact, it would be good to include the contractor in the meeting

so that the HB criteria implementation is gone through so that the contractor can see the practical side of the solution. To be able to carry out Healthy Building requirements throughout the draft design stage, the coordinators job is to make sure all design areas meet the set requirements as the client has specified.

Plans that need to be created by designers according to requirements set by the client are produced by the electrical designer, structural engineer, HVAC engineer and possibly a moisture coordinator and acoustical expert:
The architect is to deliver:

- Passive design solutions for natural light
- Material requirements for procurement according to category M1
- Specifications to structural and HVAC details in all the space types

The Electrical engineer is to deliver:

- Dialux simulations (lux)
- Lighting fixture schedule with lux and Ra values
- Room specific control options for lighting

The Structural engineer is to deliver:

- Drying time calculations
- Design in accordance with Dry Chain 10
- Moisture control plan that shows how moisture control is done in different stages

The HVAC engineer is to deliver

- Indoor temperature simulations
- HVAC service area planning according to P1 zoning
- HVAC background noise calculations
- HVAC pressure loss calculations
- Air distribution pattern simulations for all space types

Depending on client’s specifications these experts can be present in project also:
Moisture coordinator according to Dry Chain 10, can be same person as HB coordinator

- Technical risk analysis for moisture according to the Dry Chain 10
- Designer guidance according to the Dry Chain 10 requirements

Acoustical expert to ensure

- Structural solutions to meet the acoustical performance requirements through acoustical simulations

6.3 Setting contractor requirements

Once the decision about the criteria is made, it is time to set the requirements regarding construction process and site execution [1]. Especially important are the criteria for time-table planning, and requirements that add significant costs for the contractor. For successful implementation, it is of major importance that execution is discussed in detail, including such items as when to start implementing P1 cleanliness, and weather protection. At draft design phase, it is still possible to affect the solutions and steer the building process in the right direction. Therefore, it is important to bring the HB criteria requirements to the planning phase before construction even starts.

Setting the contractor requirements in a way that a construction site must follow the cleanliness requirements according to P1 is not enough. More specific goals must be set regarding P1 cleanliness execution and confirmation. Specific goals include requirements for example plans that the contractor has to produce, and measures to confirm the execution of criteria.

Practically this means setting requirements for plans that contractor needs to create and present, detailed description about how the implementation is to be confirmed at the end. Timing the P1 level execution on the worksite would be one of the things that has to be discussed, and agreed upon. All the criteria related to the project are defined by the client and contractor takes the necessary actions to fulfill them.

Requirements that the client needs to specify for the contractor:

- Subcontractors participation requirement for the HB training
- P1 cleanliness training for staff and HVAC installers
- Moisture technical plans that the contractor has to compose:
    - Weather protection plan
    - Separate weather protection plan for roof building stage
    - Moisture measurement plan that recognizes critical structures
- Cleanliness plans that the contractor has to compose:
    - P1 zoning plan with dirty working areas marked

    - For P1 cleanliness level execution during the construction process
    - HVAC works P1 cleanliness plan
- Site schedule planned according to structural drying times and cleanliness requirements
- Plan for construction handover procedures three months before handover
- Client needs to bind installment to be paid to contractor when plans are completed

Confirmation measures that the client specifies for the contractor to carry out:

- Monitoring of drying conditions
- Type and extent of the moisture measurements used
- Moisture measurements of the critical structures before installing covering materials
- Cleanliness confirmation measures

6.4 Healthy Building Coordinator

The coordinator's role in project should not be just to verify if criteria was met. A good coordinator is able to spot details that need improvement, discuss then and suggest how to fix the problems and then to ensure better end result. A Healthy Building coordinator's role is to make sure that all the criteria set by the client are met. At the draft design stage the coordinator creates specific task lists for the design areas. To be sure that all requirements are met, the coordinator tracks the HB process and reports progress after each building stage. During the draft design stage, the HB coordinator goes through plans composed by the designers and contractor and gives list about required additions to fill the requirements set by the client. It is the responsibility of the coordinator to organize meetings about the HB criteria with the designers and the contractor to discuss difficult criteria and how to implement them properly. The coordinator's task is to check all plans and confirm that there is no contradictions with the criteria.

When moving to the construction stage it is the coordinator's role to monitor the process to be executed according to HB criteria by visiting the construction site regularly. Depending on what requirements the client has set for the implementation of the HB criteria, the coordinator's tasks can vary somewhat. In any case, the tasks include monthly supervision rounds at the site, and constructive feedback discussions with the site foreman to recognize relevant measures to fix any problems encountered on the monitoring rounds. Monthly surveying rounds at worksites and constructive feedback discussion

with site foremen to point out relevant measures to fix problems found on monitoring rounds. Reporting drying and cleanliness conditions monthly supports the process and makes it possible to compare different worksites. The most valuable information that is gathered by regular monitoring to establish commonly appearing problems and preparing future projects in advance.

At the draft design stage, the coordinator should:

- Go through designer specific material from the HB perspective
- Recognize additions needed in the plans to complete HB criteria according to client's specifications
- Organize workshop about to Healthy Building implementation
- To create project specific Healthy Building monitoring schedule
- Report about Healthy Building criteria fulfillment during draft design stage

At the construction stage, the coordinator should:

- Provide worksite training about Healthy Building practices and P1 level cleanliness execution for all the workers
- Verify a feasible worksite timetable to allow for proper drying times
- Go through moisture technical and cleanliness plans composed by the contractor
- Monitor state of the weather protection during worksite
- Monitor cleanliness and drying conditions during the building stage
- Have feedback discussions with the site foreman about the measures required to meet the set HB requirements
- Verify that the handover procedures are specified according to HB criteria
- Organize group meeting with designers and construction site to discuss execution details

7 Discussion

7.1 Based on interviews and usage

Execution of the HB criteria are varies a lot between municipalities. Most of the municipalities still specified that they want to achieve the P1 level of cleanliness, S2 level indoor environment quality, and use M1 classified materials. These were common goals set in all interviewed municipalities. P1 level cleanliness requirements were met well according to clients, M1 materials did not pose any big challenge either. The biggest challenges were related to moisture technical functionality.

Typical problems that municipalities faced according to interviews:

- Healthy Building project documentation
- Lack of knowledge within smaller contractors
- Long drying times of the concrete structures caused timetable problems
- Problems to dry thick concrete structures and structures with delta beams
- Moisture problems in the structures after the building handover

Most of these problems could be solved by executing the Healthy Building process more thoroughly. Therefore, it can be concluded that a partial execution that is not documented properly is not a good way to use the HB criteria. The easiest way to approach the HB process thoroughly would be to require a Healthy Building coordinator. This person would take care of the complete documentation of the process and make sure that all design and execution areas are done according to the HB criteria. [1.]

Due to the differences in the documentation done in the municipalities it is not possible to compare them side by side. The practice in many smaller municipalities was that they require that the project is done according to the HB criteria, but the execution trusted the ethics of the individual designers that worked on the project. This does not give any reliability to the process carried out. The execution of the HB criteria would need guidance about how to document the process and rules that smaller municipalities could use if they do not appoint a coordinator to smaller projects. [1.]

Professionals that were interviewed about the process, and they saw the following development needs. References to new standards and practices in the HB criteria should be updated. From a Healthy Building coordinator’s point of view, there was a need to

develop criteria towards a general guideline so that HB criteria would refer to standards, RT –cards and best practices instead of giving strict values. The construction sites expressed a need to develop the education of clients so that they could be more precise in their execution demands. This would erase challenges caused by vague definitions.

7.2 Effect of new regulations and practices

Many new models have been developed after the release of the HB criteria. Many of the models offer additional value to the Healthy Building process. The HB criteria should be developed in the direction to generally guide more towards certain standards and therefore does not need to be updated after a new release.

A partial execution of the HB criteria did not usually cover a physical study for moisture behavior in the structures. Since there are still moisture problems present in many cases, moisture technical details should be paid attention to, and a person responsible for checking this should be appointed. For the development of the HB criteria, avoiding moisture problems should be done according to the Dry Chain 10. Technical planning for moisture according to Dry Chain 10 would also require a person to be responsible for checking the Dry Chain execution and reporting actions taken. At the same time, the Ministry of the Environment has published requirements for a moisture safety plan at a construction site. The similar details could be dropped from the HB process because they overlap with the regulations.

The HB criteria would need to be refined regarding certain type of criteria and their execution. Classification for Indoor Environment requires acoustical planning according to the standard SFS EN 5907 [6]. The HB criteria [1] does not have measures for verifying the process, neither does it guide the user to look into the standard. This is why it would be good to appoint an acoustician that is in charge for the execution of acoustical details according to the regulations.

7.3 Healthy Building criteria to solve problems in the educational buildings

According to a Finnish parliament study, and a study concluded by Finnish universities the problems in daycare and school buildings were similar. Problems that were revealed are a weak maintenance strategy and the lack of operation manual of a building, the

cleanliness of the HVAC system, a lack of knowledge at the contractor's end and poor supervision of details during the construction phase [8]. These problems are directly associated with the building process, therefore the risks can be minimized by using the HB process to guide the building project. [1.]

By implementing HB criteria to the project design and construction phases, the planning and construction process related moisture problems could be minimized and risks for moisture and mold growth would be smaller. The Healthy Building process also includes a check of structural details prior to building [1]. Extra attention should be paid to structures that are on the ground, and to run off water surfaces, such as roof structures and rainwater systems, since these seem to be most prone to face problems a during building's life cycle. [8.]

8 Conclusion

The main emphasis of this thesis was on finding how the HB criteria are used in municipalities. The aim was to recognize how the HB criteria should be developed according to the use and difficulties faced in the field. Also, as a literature study, new practices released after the HB criteria were studied to see how they could improve the Healthy Building process.

The HB criteria have been used in the municipal sector. Half of the respondents used the criteria as a guideline for projects. Goal setting and execution of the HB criteria ranges widely between municipalities. Only few of the respondents had a well documented process and a Healthy Building coordinator bound to the project. The usage of the criteria was carried out mainly as project dependent retailed usage according to the respondents. No one was using the full set of criteria that the HB criteria offers. A uniform way of documenting the HB criteria would help municipalities. Goal setting at early stages plays a vital role in a successful project.

Best execution and outcome was always achieved when there was a coordinator responsible for the execution of the process. For a successful Healthy Building process, it is vital to have a coordinator responsible for checking the plans and making sure that all goals are met. Using a coordinator to verify the process also offers the client a guarantee that they will get what they have ordered. The role of the coordinator is emphasized even more because of a variety of execution methods that are present in the field. When there

is no specified person in charge of supervising the HB criteria, the project has no assurance of meeting the set goals. At the goal setting stage, the coordinator is especially important, the coordinator can use his or her experience to determine the most critical and valuable goals that should be pursued.

The project parties saw a need for development in the HB criteria. The main areas that would need development were related to the criteria overlapping with new regulations, and with smaller contractors. The most significant problems faced at construction sites are moisture problems. From a coordinator point of view, it was seen that the HB criteria need to be developed to include a process according to the standards, and the new best practices released after the HB criteria.

The emission requirements are now limited to M1 but there are other emission classifications around Europe that should be allowed as well. The Indoor environment quality class S1 was never used in the interviewed municipalities. Therefore, S1 should be adjusted so that it would be feasible to pursue. The structural moisture challenges are the most difficult criteria at the work sites and they need to be taken into account more effectively by requiring an execution to be done according to new best practices. P1 cleanliness levels have some contradictions in the dust levels inside and outside the HVAC system and these need to be addressed.

In conclusion, the HB criteria are a good tool but it needs to be updated. The areas to address are technical guidance for moisture, the dust levels in P1, the requirements for the indoor air quality, and emission regulations.

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Healthy Building survey was concluded in Finnish language. Question groups that were asked in the survey are listed below and results can be seen in Appendices 2 & 3.

1. Is Healthy Building criteria used in your construction projects?
2. Did you take any of the following requirements into account in municipal construction projects?
3. If you did not use HB criteria, would you be intrested to use it to minimize risks for moisture, mold and indoor air problems?
4. What type of buildings you have used the Healthy Building criteria ?
5. Which of the following requirements related to HB criteria did you use ?
6. How have has the HB criteria use been specified in the projects ?
7. What have been the reasons that HB criteria has not been used in it's current form ?
8. In which stages of the project HB criteria has been used ?
9. In which contracts during the project you have specified the HB criteria requirements ?
10. How precisely HB criteria has been stated in the contracts ?
11. Which of the HB criteria entireties have been steered during the project ?
12. How has the HB criteria been steered during the project ?
13. Who has been in charge of steering and monitoring of HB criteria ?
14. Was any measurements done to confirm HB criteria fulfillment ?
15. What kind of measurements were used ?
16. What kind of benefits have you got from using HB criteria ?
17. How has HB criteria been met in the projects ?
18. Which of the requirements have been challenging during the projects ?
19. What is your opinion about why above mentioned requirements were not met ?
20. What kind of problems have you encountered in the projects using HB criteria ?
21. Do you find HB criteria to be easy to understand ?
22. What kind of challenges have you faced in the HB projects ?
23. How HB criteria should be improved to benefit clients more ?
24. Are you willing to participate in a phone interview ?

Open questions discussed with different parties

Client

Interview of the clients was based on surveys that are attached as appendices 1 and 2.

Worksite

1. How did implementing Healthy Building requirements affect to the work amount?
2. What has been the attitude towards Healthy Building process implementation?
3. How did Healthy Building requirements impact on construction costs?
4. At what stage were these costs realized?
5. How has Healthy Building criteria implementation affected to worksite operation and work environment?
6. What have been challenging requirements with Healthy building implementation?

7. How you would develop Healthy Building criteria to be more effective in contractors point of view?
8. How has implementing Healthy Building process affect to weather protection, cleanliness and moisture technical functionality of a building.

Coordinator

1. How much Healthy Building criteria has been used in the construction field?
2. What type of projects you have participated that pursued Healthy building criteria?
3. How widely Healthy Building criteria have been adapted?
4. Who has set the goals for Healthy Building requirements in projects?
5. How does the future of Healthy Building criteria usage look like?
6. What are the common problems that Healthy Building criteria has not been utilized more widely?
7. How would you develop current Healthy Building criteria?

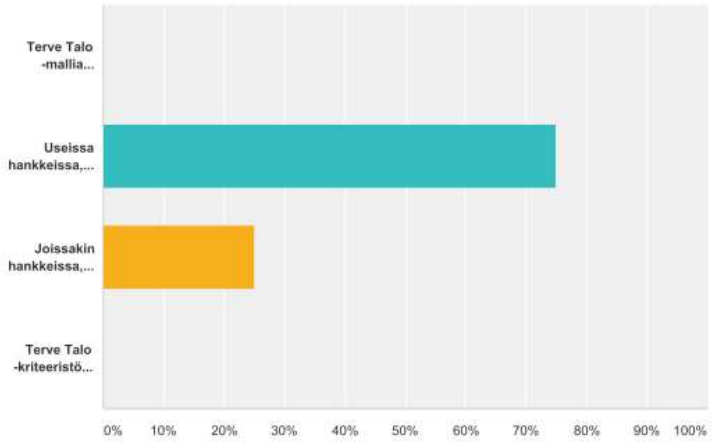
Municipalities that participated in the interviews:

- Oulu
- Jyväskylä
- Joensuu
- Helsinki
- Hollola
- Lapua
- Lempäälä
- Siilinjärvi
- Pori
- Mäntsälä
- Saarijärvi
- Ylöjärvi
- Tuusula
- Lohja
- Kaustinen

Terve Talo -Kysely

Q1 Oletteko käyttäneet Terve Talo -kriteeristöä suoraan tai sovellettuna hankkeissanne?

Vastattuja: 4 Ohitettuja: 0



Vastausvaihtoehdot	Vastaukset	
Terve Talo -mallia hyödynnetään lähes kaikissa hankkeissa	0,00%	0
Useissa hankkeissa, sellaisenaan tai sovellettuna	75,00%	3
Joissakin hankkeissa, sellaisenaan tai sovellettuna	25,00%	1
Terve Talo -kriteeristöä ei ole hyödynnetty hankkeissa missään muodossa	0,00%	0
Yhteensä		4

Terve Talo -Kysely

Q2 Huomioitteko joitain seuraavista kokonaisuuksista hankkeissanne, joissa ei Terve Talo -mallia ei käytetä?

Vastattuja: 0 Ohitettuja: 4

⚠ Ei sopivia vastauksia.

Vastausvaihtoehdot	Vastaukset	
Emissiovaatimukset (M1 tai TVOC-mittaukset)	0,00%	0
Kosteudenhallintavaatimukset (Työmaan kosteusriskien tunnistaminen ja hallinta)	0,00%	0
Kosteustekniset riskit (Rakennusfysikaaliset tarkastelut)	0,00%	0
Sisäilmastovaatimukset (Tavoitearvot, Huonelämpötilat, Laatuvaatimukset, Järjestelmäkaaviot)	0,00%	0
Ilmastointisuunnittelu (Äänitasolaskelmat, Päätelaitteiden sekä IV-peltien esisäätöarvot)	0,00%	0
Lämmityssuunnittelun vaatimukset (Kylmäsillat, ikkunoiden u-arvot, toiminta- ja säätökokeet eri vuodenaikoina)	0,00%	0
Valaistusvaatimukset (Lux, UGR, dialux-laskenta)	0,00%	0
Työmaan toteutusvaatimukset (Sääsuojat, Materiaalivarastot, Kuivatus)	0,00%	0
Työmaan puhtaudenhallinta vaatimukset (P1)	0,00%	0
Työmaan kosteudenhallinta vaatimukset (Kosteusriskien hallinta, Kuivumisajat)	0,00%	0
Vastaajat yhteensä: 0		

Terve Talo -Kysely

Q3 Jos Terve Talo -mallia ei ole käytetty tai se ei ole entuudestaan tuttu, kiinnostaisiko Terve Talo -mallin hyödyntäminen hankkeidenne home-, sisäilma-, kosteus- ja puhtausriskien minimoimiseksi?

Vastattuja: 0 Ohitettuja: 4

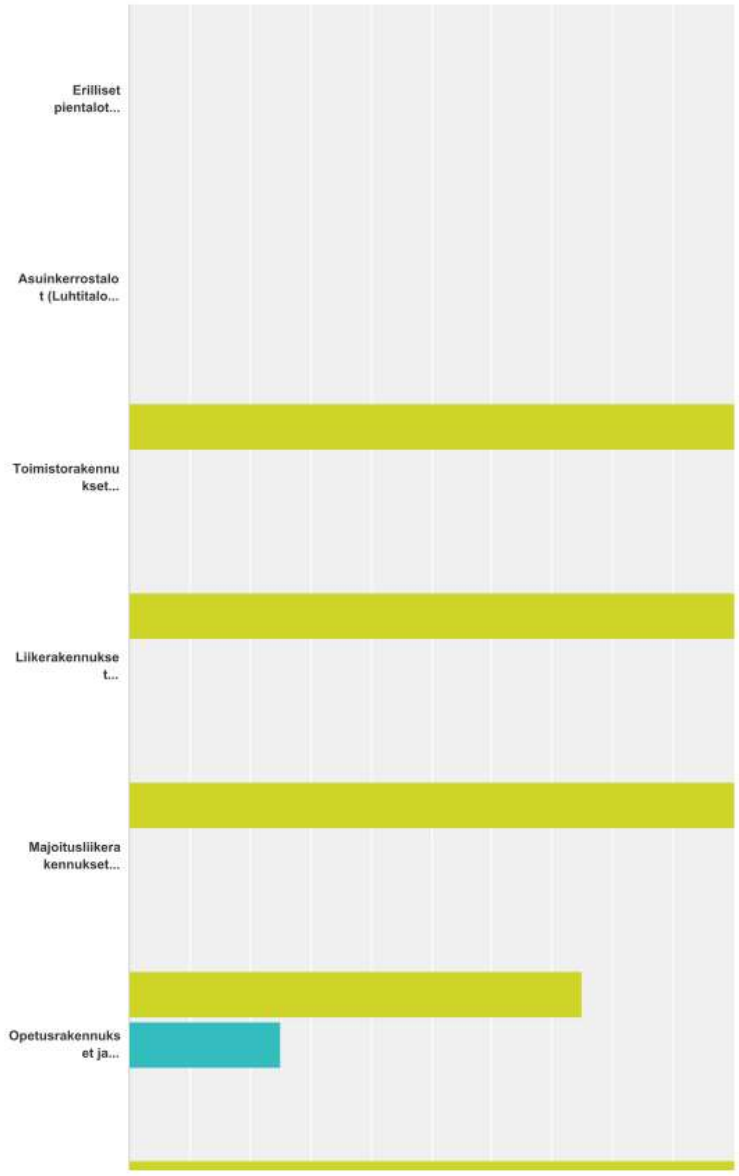
⚠ Ei sopivia vastauksia.

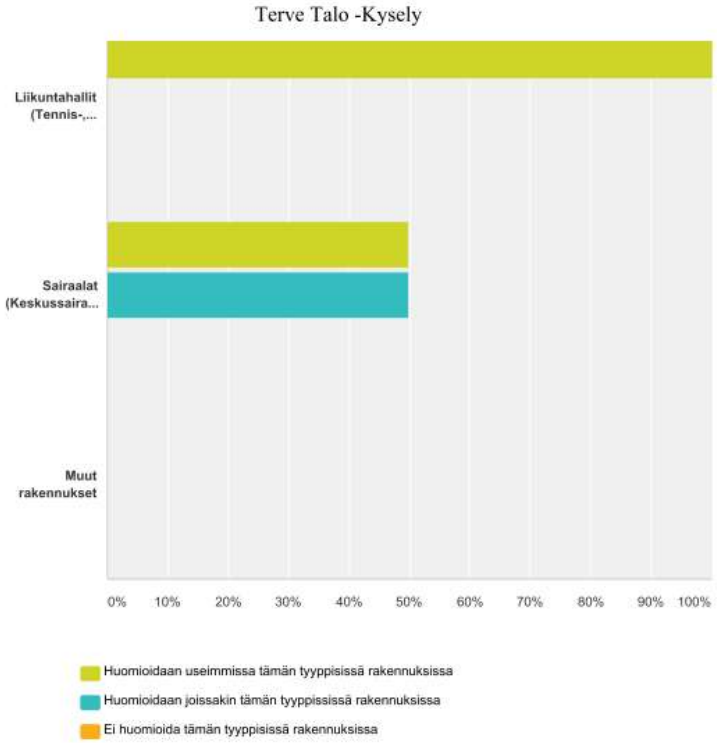
Vastausvaihtoehdot	Vastaukset	
Kyllä	0,00%	0
Ei	0,00%	0
Yhteensä		0

Terve Talo -Kysely

Q4 Millaissa rakennuksissa olette hyödyntäneet Terve Talo -kriteereitä

Vastattuja: 4 Ohitettuja: 0



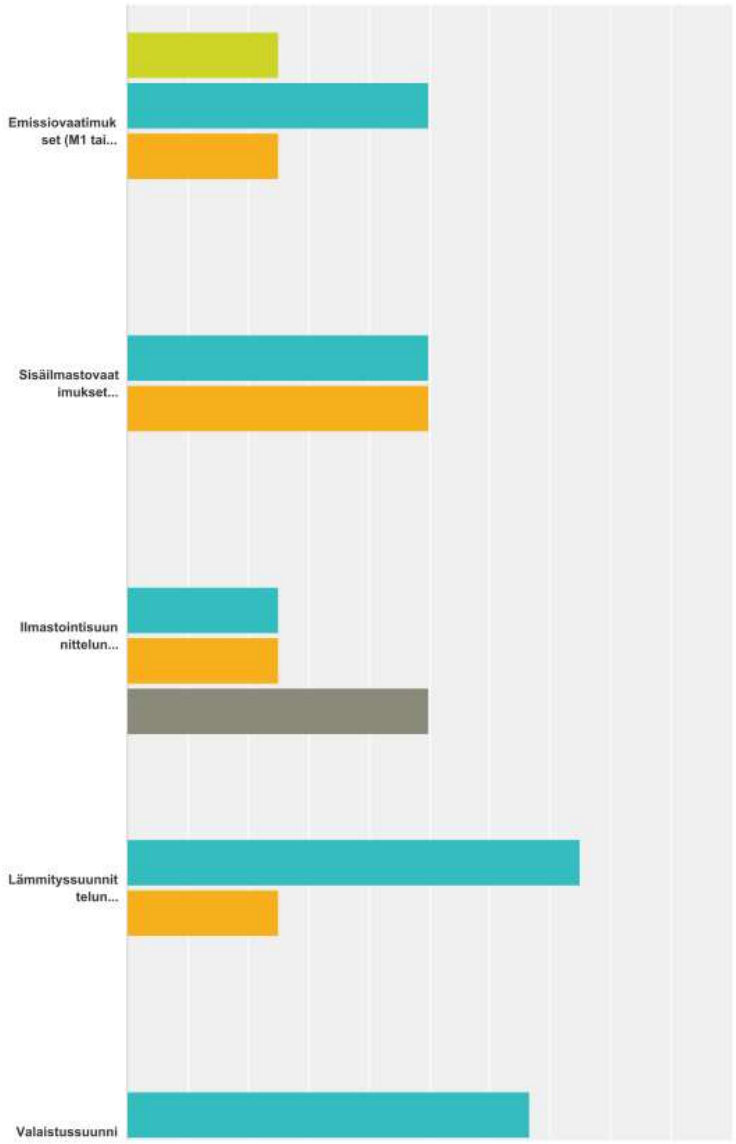


	Huomioidaan useimmissa tämän tyyppisissä rakennuksissa	Huomioidaan joissakin tämän tyyppississä rakennuksissa	Ei huomioida tämän tyyppisissä rakennuksissa	Yhteensä
Erilliset pientalot (rivi- ja ketjutalot)	**0,00%** 0	**0,00%** 0	**0,00%** 0	0
Asuinkerrostalot (Luhtitalot, muut asuinkerrostalot)	**0,00%** 0	**0,00%** 0	**0,00%** 0	0
Toimistorakennukset (Toimistorakennukset, Terveyskeskukset)	**100,00%** 2	**0,00%** 0	**0,00%** 0	2
Liikerakennukset (Myymälärakennukset, Kirjastot, Museot, Liike- ja tavaratalot, Elokuvateatterit, Myymälähallit, Teatteri)	**100,00%** 2	**0,00%** 0	**0,00%** 0	2
Majoitusliikerakennukset (Hotellit, Asuntolat, Vanhainkodit, Lasten- ja koulukodit, Kehitysvammaisten hoitolaitokset)	**100,00%** 2	**0,00%** 0	**0,00%** 0	2
Opetusrakennukset ja päiväkodit (Lasten päiväkodit, Yleissivistävien oppilaitosten rakennukset, Ammatillisten oppilaitosten rakennukset, Korkeakoulurakennukset, Tutkimuslaitoisrakennukset)	**75,00%** 3	**25,00%** 1	**0,00%** 0	4
Liikuntahallit (Tennis-, squashhallit, Monitoimihallit)	**100,00%** 1	**0,00%** 0	**0,00%** 0	1
Sairaalat (Keskussairaalat, Muut sairaalat)	**50,00%** 1	**50,00%** 1	**0,00%** 0	2
Muut rakennukset	**0,00%** 0	**0,00%** 0	**0,00%** 0	0

Terve Talo -Kysely

Q5 Mitä seuraavista Terve Talo -kriteereistä olette huomioineet ja millä tasolla hankkeissanne

Vastattuja: 4 Ohitettuja: 0



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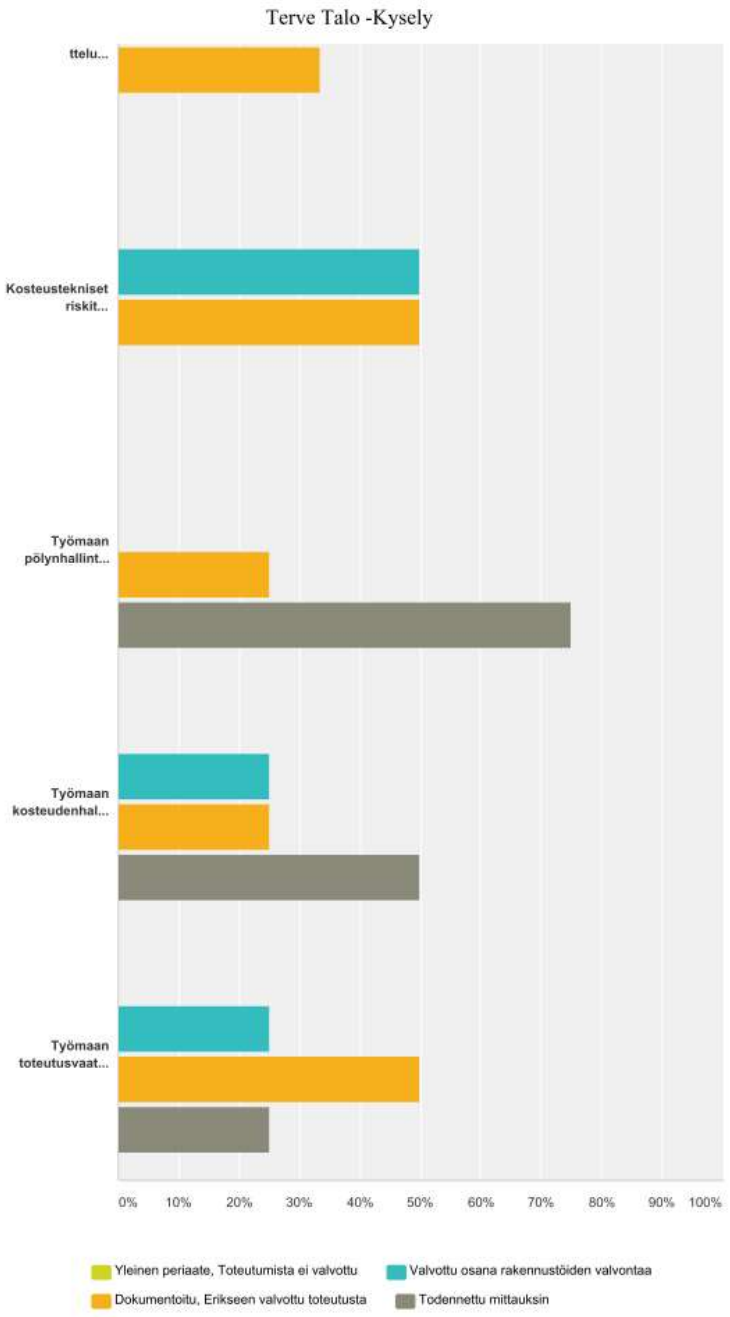

Terve Talo -Kysely
ttelu...
Kosteustekniset riskit...
Työmaan pölynhallint...
Työmaan kosteudenhal...
Työmaan toteutusvaat...
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Yleinen periaate, Toteutumista ei valvottu
Valvottu osana rakennustöiden valvontaa
Dokumentoitu, Erikseen valvottu toteutusta
Todennettu mittauksin

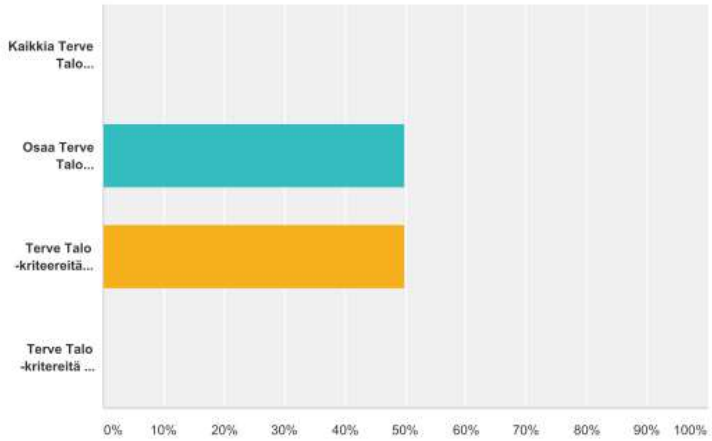
Terve Talo -Kysely

	Yleinen periaate, Toteutumista ei valvottu	Valvottu osana rakennustöiden valvontaa	Dokumentoitu, Erikseen valvottu toteutusta	Todennettu mittauksin	Yhteensä
Emissiovaatimukset (M1 tai TVOC-mittaukset)	**25,00%** 1	**50,00%** 2	**25,00%** 1	**0,00%** 0	4
Sisäilmastovaatimukset (Tavoitearvot, Huonelämpötilat, Laatuvaatimukset, Järjestelmäkaaviot)	**0,00%** 0	**50,00%** 2	**50,00%** 2	**0,00%** 0	4
Ilmastointisuunnittelun vaatimukset (Äänitasolaskelmat, Päätelaitteiden sekä IV-peltien esisäätöarvot)	**0,00%** 0	**25,00%** 1	**25,00%** 1	**50,00%** 2	4
Lämmityssuunnittelun vaatimukset (Kylmäsillat, ikkunoiden u-arvot, toiminta- ja säätökokeet eri vuodenaikoina)	**0,00%** 0	**75,00%** 3	**25,00%** 1	**0,00%** 0	4
Valaistussuunnittelu vaatimukset (Valaisinvaatimukset, UGR, dialux-laskenta)	**0,00%** 0	**66,67%** 2	**33,33%** 1	**0,00%** 0	3
Kosteustekniset riskit suunnitteluvaiheessa (Rakennusfysikaaliset tarkastelut)	**0,00%** 0	**50,00%** 2	**50,00%** 2	**0,00%** 0	4
Työmaan pölynhallinta vaatimukset (P1)	**0,00%** 0	**0,00%** 0	**25,00%** 1	**75,00%** 3	4
Työmaan kosteudenhallinnan vaatimukset (Työmaan kosteusriskien tunnistaminen ja hallinta, rakenteiden kuivumisajat)	**0,00%** 0	**25,00%** 1	**25,00%** 1	**50,00%** 2	4
Työmaan toteutusvaatimukset (Sääsuojat, Materiaalivarastot, Rakenteiden kuivatus)	**0,00%** 0	**25,00%** 1	**50,00%** 2	**25,00%** 1	4

Terve Talo -Kysely

Q6 Miten Terve Talo -kriteeristöä on käytetty hankkeissa yleensä?

Vastattuja: 4 Ohitettuja: 0

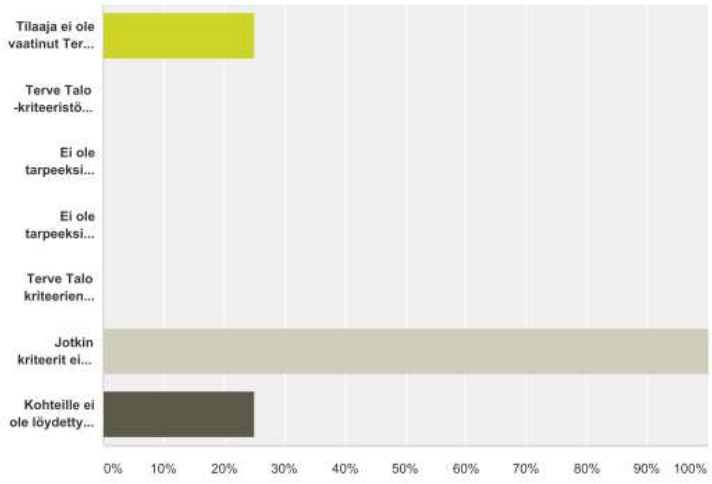


Vastausvaihtoehdot	Vastaukset	
Kaikkia Terve Talo -kriteereitä on käytetty sellaisenaan	0,00%	0
Osaa Terve Talo -kriteereistä on käytetty sellaisenaan	50,00%	2
Terve Talo -kriteereitä on käytetty soveltaen	50,00%	2
Terve Talo -kritereitä on käytetty ohjaavina	0,00%	0
Yhteensä		4

Terve Talo -Kysely

Q7 Mistä johtuu että Terve Talo -kriteereitä ei ole käytetty nykyisessä muodossa?

Vastattuja: 4 Ohitettuja: 0



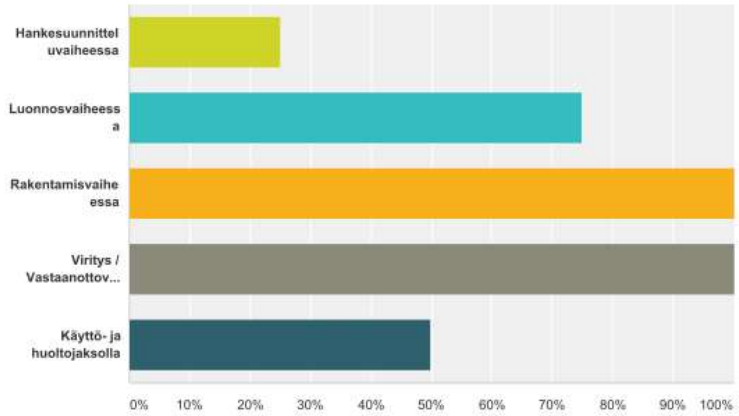
Vastausvaihtoehdot	Vastaukset	
Tilaaja ei ole vaatinut Terve Talo -kriteerien toteuttamista	25,00%	1
Terve Talo -kriteeristön toteuttaminen aiheuttaisi liikaa kustannuksia	0,00%	0
Ei ole tarpeeksi tietoa kriteeristöstä kokonaisuutena	0,00%	0
Ei ole tarpeeksi tietoa yksittäisistä kriteereistä ja niiden toteutuksesta	0,00%	0
Terve Talo kriteerien todentamisessa on ollut epäselvyyttä	0,00%	0
Jotkin kriteerit eivät sovellu sellaisenaan kohteeseen, jonka vuoksi toteutettu sovellettuna	100,00%	4
Kohteille ei ole löydetty Terve Talo -ohjausta tai Valvontaa	25,00%	1
Vastaajat yhteensä: 4		

#	Jonkin muu syy?	Päivämäärä
1	Helsingin kaupunki kehittää toimintaansa. Meneillään on rakentamisprosessin toimivuuden varmistamisen (ToVa) kehittäminen, jossa Terveen talon toteutuksen kriteereitä voitaisiin hyödyntää hankkeissa.	9.12.2016 18:27

Terve Talo -Kysely

Q8 Missä hankkeen vaiheissa olette hyödyntäneet Terve Talo -kriteeristöä?

Vastattuja: 4 Ohitettuja: 0

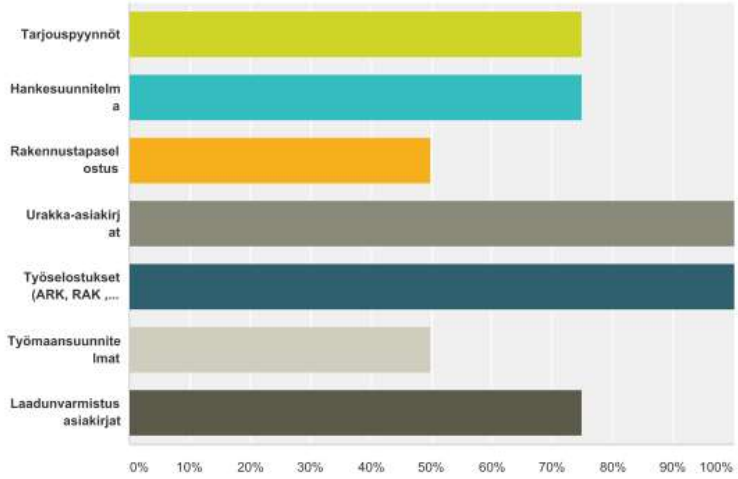


Vastausvaihtoehdot	Vastaukset	
Hankesuunnitteluvaiheessa	25,00%	1
Luonnosvaiheessa	75,00%	3
Rakentamisvaiheessa	100,00%	4
Viritys / Vastaanottovaiheessa	100,00%	4
Käyttö- ja huoltojaksolla	50,00%	2
Vastaajat yhteensä: 4		

Terve Talo -Kysely

Q9 Oletteko sisällyttäneet käyttämänne Terve Talo -kriteerit seuraaviin asiakirjoihin?

Vastattuja: 4 Ohitettuja: 0

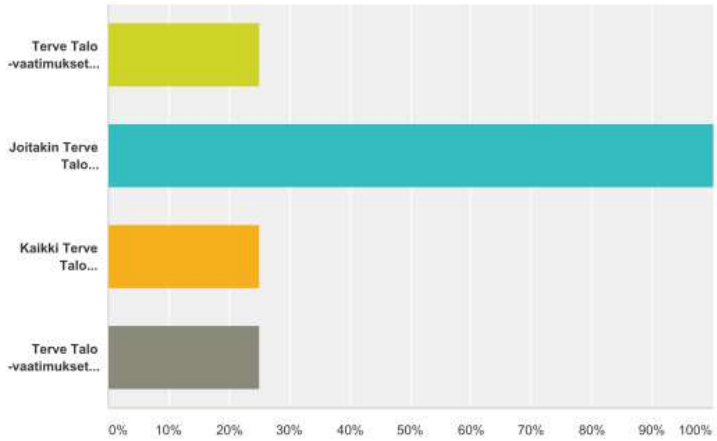


Vastausvaihtoehdot	Vastaukset	
Tarjouspyynnöt	75,00%	3
Hankesuunnitelma	75,00%	3
Rakennustapaselostus	50,00%	2
Urakka-asiakirjat	100,00%	4
Työselostukset (ARK, RAK , SÄH, LVI)	100,00%	4
Työmaansuunnitelmat	50,00%	2
Laadunvarmistusasiakirjat	75,00%	3
Vastaajat yhteensä: 4		

Terve Talo -Kysely

Q10 Kuinka tarkasti olette kirjanneet Terve Talo -vaatimukset asiakirjoihin?

Vastattuja: 4 Ohitettuja: 0



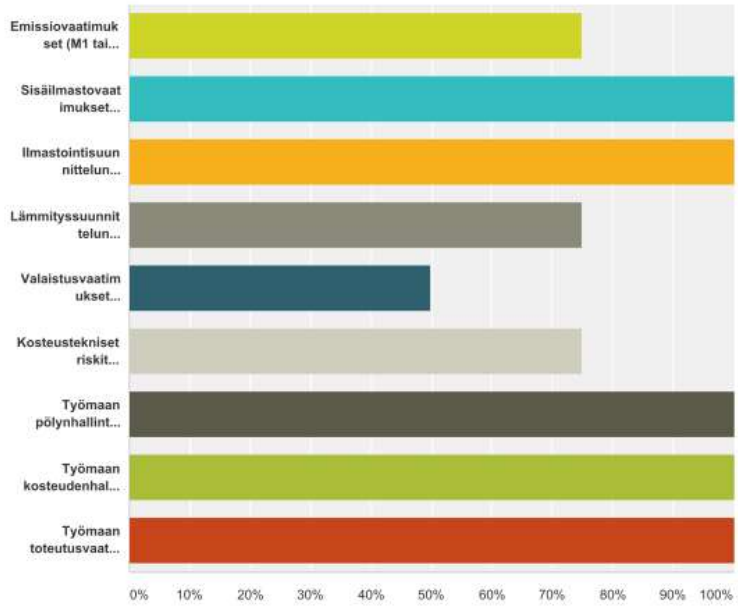
Vastausvaihtoehdot	Vastaukset	
Terve Talo -vaatimukset on kirjattu mainintana asiakirjoihin	25,00%	1
Joitakin Terve Talo -vaatimuksia on avattu ja kirjattu yksiselitteisesti asiakirjoihin	100,00%	4
Kaikki Terve Talo -vaatimukset on kirjattu yksityiskohtaisesti suunnittelualoittain asiakirjoihin	25,00%	1
Terve Talo -vaatimukset on käyty yksityiskohtaisesti läpi suunnittelualoittain palavereissa	25,00%	1
Vastaajat yhteensä: 4		

#	Kommentti / Tarkennus	Päivämäärä
1	HKR-Rakennuttaja on laatinut mm. kosteuden- ja puhtaudenhallinta-asiakirjat, joita urakoitsijoita velvoitetaan noudattamaan.	9.12.2016 18:34

Terve Talo -Kysely

Q11 Oletteko ohjanneet hankkeissanne joitakin seuraavista kokonaisuuksista?

Vastattuja: 4 Ohitettuja: 0

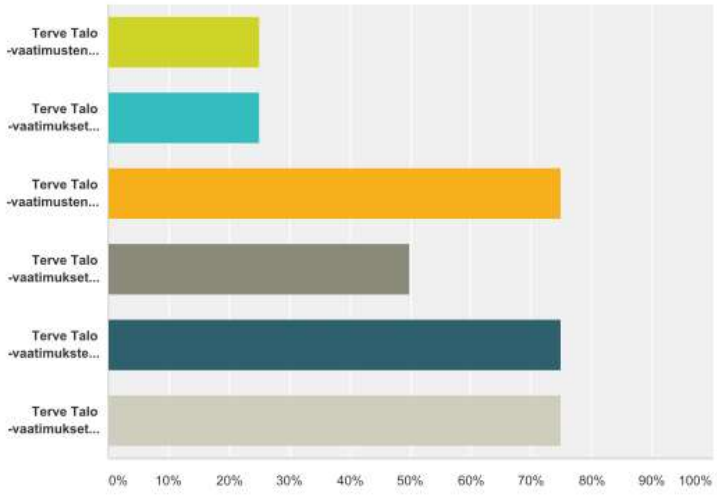


Vastausvaihtoehdot	Vastaukset	
Emissiovaatimukset (M1 tai TVOC-mittaukset)	75,00%	3
Sisäilmastovaatimukset (Tavoitearvot, Huonelämpötilat, Laatuvaatimukset, Järjestelmäkaaviot)	100,00%	4
Ilmastointisuunnittelun vaatimukset (Äänitasolaskelmat, Päätelaitteiden sekä IV-peltien esisäätöarvot)	100,00%	4
Lämmityssuunnittelun vaatimukset (Kylmäsillat, ikkunoiden u-arvot, toiminta- ja säätökokeet eri vuodenaikoina)	75,00%	3
Valaistusvaatimukset (Valaisinvaatimukset, UGR, dialux-laskenta)	50,00%	2
Kosteustekniset riskit (Rakennusfysikaaliset tarkastelut)	75,00%	3
Työmaan pölynhallinta vaatimukset	100,00%	4
Työmaan kosteudenhallinnan vaatimukset (Työmaan kosteusriskien tunnistaminen ja hallinta, rakenteiden kuivumisajat)	100,00%	4
Työmaan toteutusvaatimukset (Säänsuojat, Materiaalivarastot, Kuivatus)	100,00%	4
Vastaajat yhteensä: 4		

Terve Talo -Kysely

Q12 Millä tarkkuudella olette ohjanneet Terve Talo -toteutusta

Vastattuja: 4 Ohitettuja: 0



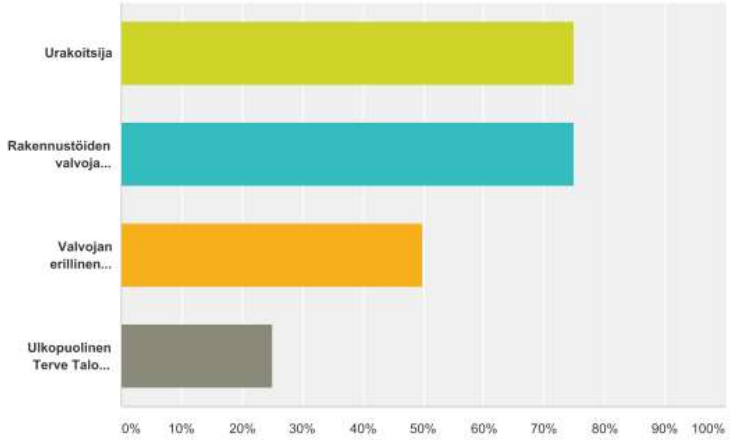
Vastausvaihtoehdot	Vastaukset	
Terve Talo -vaatimusten kirjaus suunnitelma asiakirjoihin on varmennettu	25,00%	1
Terve Talo -vaatimukset on kirjattu auki ja vastuu henkilöt on nimetty	25,00%	1
Terve Talo -vaatimusten mukaisten toimenpiteiden toteuttaminen on käsitelty palaverissa	75,00%	3
Terve Talo -vaatimukset on ohjeistettu yksityiskohtaisesti suunnittelijoille	50,00%	2
Terve Talo -vaatimuksten toteutus on ohjeistettu yksityiskohtaisesti pääurakoitsijalle	75,00%	3
Terve Talo -vaatimukset on käyty läpi suunnittelia palaverissa	75,00%	3
Vastaajat yhteensä: 4		

#	Vaatimukset on käsitelty jollain muulla tavalla	Päivämäärä
	Vastauksia ei ole.	

Terve Talo -Kysely

Q13 Kuka on vastannut Terve Talo -kriteerien toteutuksen valvonnasta ja ohjauksesta hankkeissanne?

Vastattuja: 4 Ohitettuja: 0



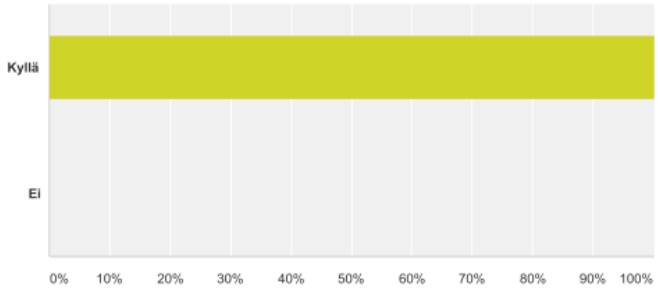
Vastausvaihtoehdot	Vastaukset	
Urakoitsija	75,00%	3
Rakennustöiden valvoja yleisvalvonnan ohessa	75,00%	3
Valvojan erillinen asiantuntija	50,00%	2
Ulkopuolinen Terve Talo -konsultti	25,00%	1
Vastaajat yhteensä: 4		

#	Joku muu	Päivämäärä
1	LVI-rakennuttaja ja projektinjohtaja	9.12.2016 18:39
2	Sekä hankekohtainen kokonaisvastuusuunnitteluryhmä.	9.12.2016 15:32

Terve Talo -Kysely

Q14 Hyödynsittekö mittauksia Terve Talo -varmennuksessa?

Vastattuja: 4 Ohitettuja: 0

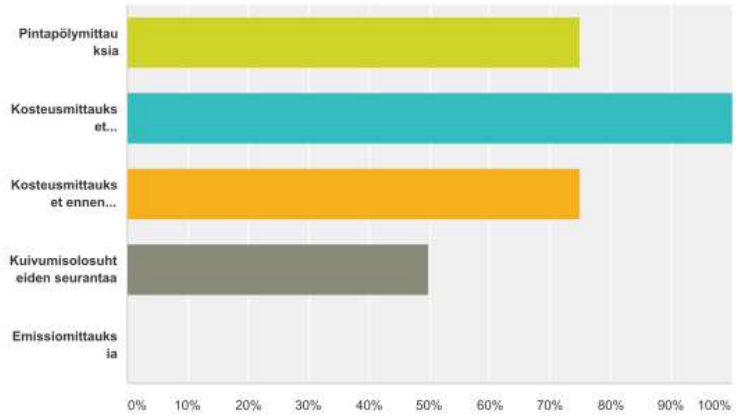


Vastausvaihtoehdot	Vastaukset	
Kyllä	**100,00%**	4
Ei	**0,00%**	0
Yhteensä		**4**

Terve Talo -Kysely

Q15 Minkälaisia mittauksia käytitte?

Vastattuja: 4 Ohitettuja: 0



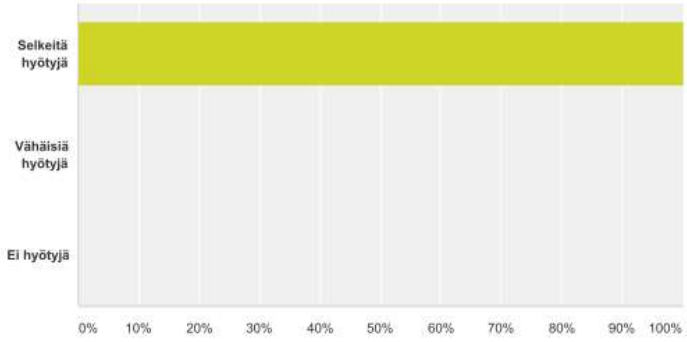
Vastausvaihtoehdot	Vastaukset	
Pintapölymittauksia	**75,00%**	3
Kosteusmittaukset kuivumisjaksolla	**100,00%**	4
Kosteusmittaukset ennen pinnoituksia	**75,00%**	3
Kuivumisolosuhteiden seurantaa	**50,00%**	2
Emissiomittauksia	**0,00%**	0
Vastaajat yhteensä: 4		

#	Joitain muita varmentavia mittauksia	Päivämäärä
1	Pintapölymittaukset on tehnyt LVI-rakennuttaja, rakennustöiden valvoja tai ulkopuolinen konsultti. Kosteusmittaukset on tehnyt urakoitsijan tilaama ulkopuolinen konsultti.	9.12.2016 18:39
2	Kohteen q50 tiiveysmittaus, painekoemittaukset, pohjrakenteiden tiiveysmittaukset, LVI-painekoemittaukset, sähkövarmennusmitaukset, Ulkovaipan lämpökamera- ja viemärikuvaukset.	9.12.2016 15:32

Terve Talo -Kysely

Q16 Minkälaisia kokemuksia olette saaneet Terve Talo -kriteerien käytöstä

Vastattuja: 4 Ohitettuja: 0



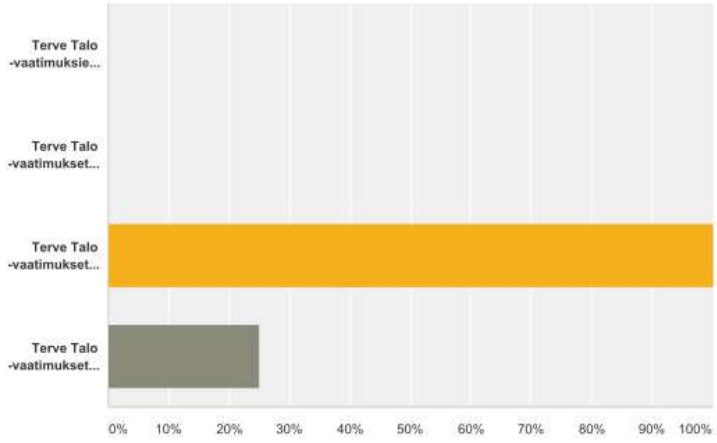
Vastausvaihtoehdot	Vastaukset	
Selkeitä hyötyjä	**100,00%**	4
Vähäisiä hyötyjä	**0,00%**	0
Ei hyötyjä	**0,00%**	0
Vastaajat yhteensä: 4		

#	Millaisia hyötyjä olette saaneet?	Päivämäärä
1	Kohteelle asetetut TT tavoitearvojen määritykset ohjaavat erinomaisesti hankekohtaisia laatuvaatimuksia.	9.12.2016 15:34
2	Työmaiden puhtaustasot ovat pysyneet hyvinä. Sääsuojaus on parantunut. Ilmanvaihtolaitteiden puhtausvaatimukset ovat täyttyneet. On kiinnitetty enemmän huomioita rakennusfysikaaliseen toimintaan.	1.12.2016 20:21

Terve Talo -Kysely

Q17 Miten Terve Talo -vaatimusten toteutus on onnistunut projekteissanne?

Vastattuja: 4 Ohitettuja: 0



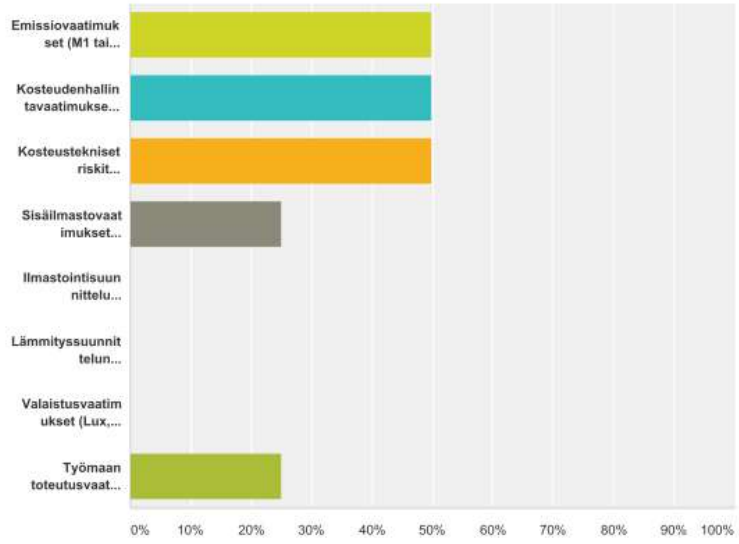
Vastausvaihtoehdot	Vastaukset	
Terve Talo -vaatimuksien toteutumista ei ole seurattu	0,00%	0
Terve Talo -vaatimukset ovat toteutuneet vähäisin osin	0,00%	0
Terve Talo -vaatimukset ovat toteutuneet suurelta osin	100,00%	4
Terve Talo -vaatimukset ovat toteutuneet kohteissa	25,00%	1
Vastaajat yhteensä: 4		

#	Voit tarkentaa vaatimusten toteutumista tähän	Päivämäärä
1	Jotakin tavoitearvoa ollaan jouduttu sunnitteluvaiheessa pudottamaan kustannussyistä johtuen.	9.12.2016 15:34
2	Deltapalkkien aiheuttamaa kosteuskuormaa ei ole onnistuttu hallitsemaan. Puhtaudenhallinta on onnistunut hyvin. Siinä on käytetty erillistä konsulttia.	1.12.2016 20:21

Terve Talo -Kysely

Q18 Minkä tyyppiset kriteerit ovat olleet haasteellisia tai eivät ole toteutuneet?

Vastattuja: 4 Ohitettuja: 0

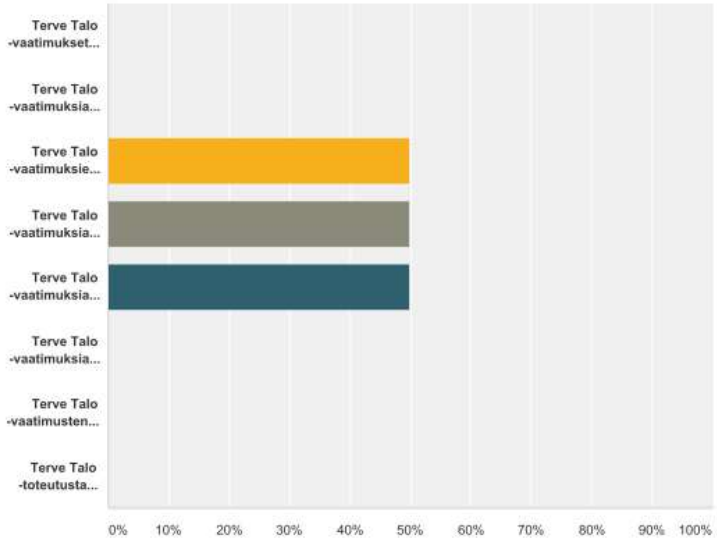


Vastausvaihtoehdot	Vastaukset	
Emissiovaatimukset (M1 tai TVOC-mittaukset)	50,00%	2
Kosteudenhallintavaatimukset (Työmaan kosteusriskien tunnistaminen ja hallinta)	50,00%	2
Kosteustekniset riskit (Rakennusfysikaaliset tarkastelut)	50,00%	2
Sisäilmastovaatimukset (Tavoitearvot, Huonelämpötilat, Laatuvaatimukset, Järjestelmäkaaviot)	25,00%	1
Ilmastointisuunnittelu (Äänitasolaskelmat, Päätelaitteiden sekä IV-peltien esisäätöarvot)	0,00%	0
Lämmityssuunnittelun vaatimukset (Kylmäsillat, ikkunoiden u-arvot, toiminta- ja säätökokeet eri vuodenaikoina)	0,00%	0
Valaistusvaatimukset (Lux, UGR, dialux-laskenta)	0,00%	0
Työmaan toteutusvaatimukset (Sääsuojat, Materiaalivarastot, Kuivatus)	25,00%	1
Vastaajat yhteensä: 4		

Terve Talo -Kysely

Q19 Mistä mielestäsi johtui että edellisen kohdan kriteerit eivät ole täyttyneet?

Vastattuja: 2 Ohitettuja: 2



Vastausvaihtoehdot	Vastaukset	
Terve Talo -vaatimukset ovat epäselviä	0,00%	0
Terve Talo -vaatimuksia ei toteutettu väliinpitämättömyydestä	0,00%	0
Terve Talo -vaatimuksien osalta ei asetettu riittävän selkeitä tavotteita	50,00%	1
Terve Talo -vaatimuksia ei kirjattu tarpeeksi selkeästi suunnitelmiin	50,00%	1
Terve Talo -vaatimuksia ei välitetty tarpeeksi selkeästi suunnittelijoille ja urakoitsijalle	50,00%	1
Terve Talo -vaatimuksia ei varmennettu erikseen	0,00%	0
Terve Talo -vaatimusten toteutuksesta vastaavia tahoja ei oltu nimetty	0,00%	0
Terve Talo -toteutusta valvovaa osapuolta ei oltu nimetty	0,00%	0
Vastaajat yhteensä: 2		

#	Jostain muusta syystä	Päivämäärä
1	Lastenkodin majoitusrakennus suunniteltiin rakennettavan sääsuojan alla. Uudishankkeessa rakentaminen sääsuojan alla osoittautui liian haastavaksi. Sääsuojaa ei ole.	9.12.2016 18:49
2	Koulutoimintaa ei ole kouluissa kesällä, joten lämpö- ,ja sisäilmaluokkien tavoitearvoksi määritellään yleensä S2, missä ei välttämättä huomioida kesä- ja heinäkuuta.	9.12.2016 15:34
3	Esim. Deltapalkkien kosteudenhallinnan ohjeet saatiin vasta huhtikuussa 2016 vaikka niitä on käytetty 20 vuotta.	1.12.2016 20:21

Terve Talo -Kysely

Q20 Minkä tyyppisiä ongelmia Terve Talo - hankkeissanne on ilmennyt?

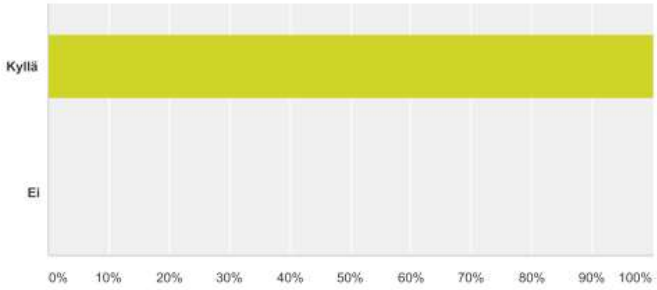
Vastattuja: 3 Ohitettuja: 1

#	Vastaukset	Päivämäärä
1	Aikatauluongelmia. Puhtaudenhallinta-asiakirjojen loppusiivousvaatimukset viivyttävät talotekniikan säätöjen ja viritysten aloittamista ja niille jää liian vähän aikaa. Urakan aikataulutus olisi suunniteltava Terve Talo -vaatimusten saavuttamiseksi uudella tavalla.	9.12.2016 18:49
2	Pienten - ja keskisuurten urakoitsijoiden tietämättömyys.	9.12.2016 15:34
3	IMS-laitteiden vikaantuminen ja ilmanvaihdon säätö yleensä on ollut ongelmana. Kumimattojen emissiot ja deltapalkkien aiheuttaman kosteuden kertyminen kumi- tai muovimattojen alle ja siitä johtuneet emissiot/VOC-ongelmat. Kylmäsiltoja on joskus jäänyt. Väestönsuojien yläpuolisen tilan kuivuminen on epäonnistunut. Bulletin Board kiinnitystaulujen, liikuntasalin väliverhojen ja kumimattojen voimakkaat emissiot.	1.12.2016 20:21

Terve Talo -Kysely

Q21 Onko Terve Talo -kriteeristö mielestäsi tarpeeksi yksiselitteinen ja selkeä?

Vastattuja: 3 Ohitettuja: 1



Vastausvaihtoehdot	Vastaukset	
Kyllä	**100,00%**	3
Ei	**0,00%**	0
Yhteensä		**3**

#	Miten kriteeristöä tulisi mielestäsi kehittää toimivammaksi?	Päivämäärä
1	Sisäilmastoluokitus 2008 päivittää nykypäivän tasolle, kosteudenhallinnan ohjeeksi kuivaketju 10 ja kestäväkehitys mukaan.	9.12.2016 15:36

Terve Talo -Kysely

Q22 Minkälaisia käytännön haasteita on ilmennyt Terve Talo -hankkeen toteutuksessa?

Vastattuja: 3 Ohitettuja: 1

#	Vastaukset	Päivämäärä
1	Aikatauluongelmia. Puhtaudenhallinnan vuoksi talotekniikan säätö- ja viritystöihin ei jää riittävästi aikaa.	9.12.2016 18:52
2	IV-kammioiden lattian pintamateriaalin M1-luokitus ja kosteusriski ovat ristiriidassa keskenään.	9.12.2016 15:38
3	Ohjeiden jatkuva peilaaminen suunnitteluun ja toteutukseen ei ole riittävää.	1.12.2016 20:25

Terve Talo -Kysely

Q23 Miten Terve Talo -mallia tulisi mielestäsi kehittää, jotta siitä saisi suuremman hyödyn?

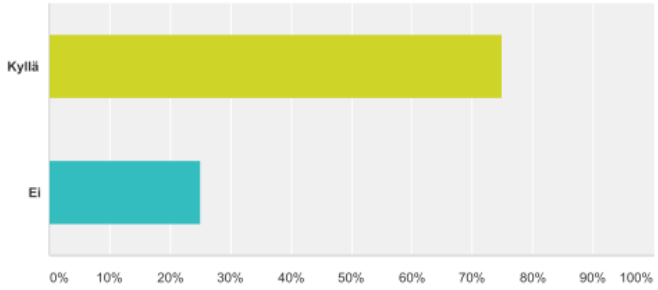
Vastattuja: 3 Ohitettuja: 1

#	Vastaukset	Päivämäärä
1	Se tulee liittää osaksi toimivuuden varmistamisen prosessia, joka ulottuu hankesuunnittelusta takuuajan loppuun. Toimivuuden varmistamisessa tulee huolehtia kaikkien muiden asioiden rinnalla, että aikataulutus on realistinen ja siinä on tarpeeksi aikaa talotekniikan säädöille ja virityksille.	9.12.2016 18:52
2	Purkaa hierarkia talo-80 litteran mukaiseen järjestykseen hankesuunnittelusta alkaen - takuuaikaan päättyen.	9.12.2016 15:38
3	Pitäisi kehittää jokin selkeä Terve Talo dokumentointijärjestelmä, johon koottaisiin koko hankkeen Terve Talo dokumentit. Hankkeissa pitäisi olla erillinen Terve Talo asiantuntija, joka suunnittelisi hankekohtaiset Terve Talo vaatimukset, valvoisi niiden toteutusta ja dokumentoisi sen.	1.12.2016 20:25

Terve Talo -Kysely

Q24 Olisitko kiinnostunut osallistumaan puhelinhaastatteluun kyselyyn liittyen?

Vastattuja: 4 Ohitettuja: 0

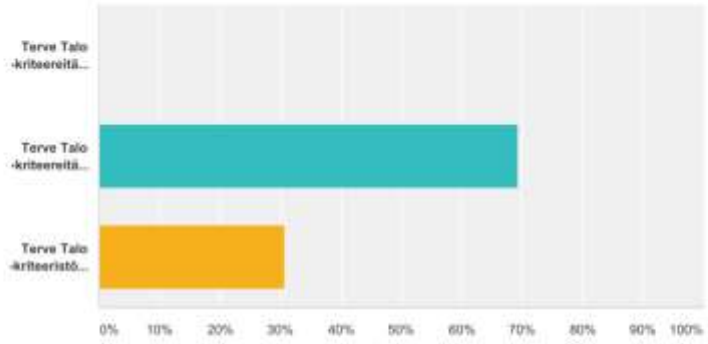


Vastausvaihtoehdot	Vastaukset	
Kyllä	**75,00%**	3
Ei	**25,00%**	1
Yhteensä		**4**

Terve Talo -Kartoitus suppea

Q1 Oletteko käyttäneet Terve Talo -kriteeristöä suoraan tai sovellettuna hankkeissanne?

Vastattuja: 13 Ohitettuja: 0

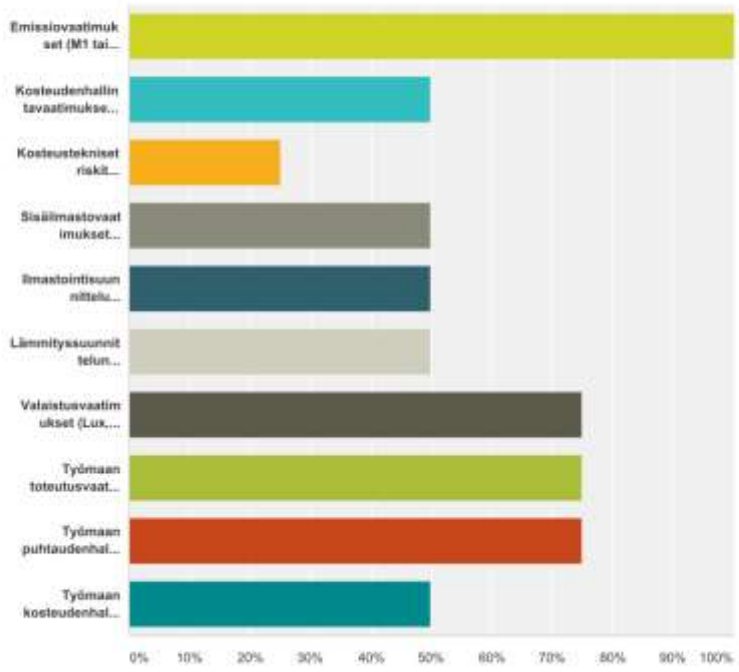


Vastausvaihtoehdot	Vastaukset	
Terve Talo -kriteereitä hyödynnetään hankkeissa sellaisenaan	0,00%	0
Terve Talo -kriteereitä hyödynnetään hankkeissa sovellettuna	69,23%	9
Terve Talo -kriteeristöä ei ole hyödynnetty hankkeissa missään muodossa	30,77%	4
Yhteensä		13

Terve Talo -Kartoitus suppea

Q2 Huomioitteko joitain seuraavista kokonaisuuksista hankkeissanne, joissa ei Terve Talo -mallia ei käytetä?

Vastattuja: 4 Ohitettuja: 9



Vastausvaihtoehdot	Vastaukset	
Emissiovaatimukset (M1 tai TVOC-mittaukset)	100,00%	4
Kosteudenhallintavaatimukset (Työmaan kosteusriskien tunnistaminen ja hallinta)	50,00%	2
Kosteustekniset riskit (Rakennusfysikaaliset tarkastelut)	25,00%	1
Sisäilmastovaatimukset (Tavoitearvot, Huonelämpötilat, Laatuvaatimukset, Järjestelmäkaaviot)	50,00%	2
Ilmastointisuunnittelu (Äänitasolaskelmat, Päätelaitteiden sekä IV-pellien esisäätöarvot)	50,00%	2
Lämmitysuunnittelun vaatimukset (Kylmäsillat, ikkunoiden u-arvot, toiminta- ja säätökokeet eri vuodenaikoina)	50,00%	2
Valaistusvaatimukset (Lux, UGR, dialux-laskenta)	75,00%	3
Työmaan toteutusvaatimukset (Sääsuojat, Materiaalivarastot, Kuivatus)	75,00%	3
Työmaan puhtaudenhallinta vaatimukset (P1)	75,00%	3
Työmaan kosteudenhallinta vaatimukset (Kosteusriskien hallinta, Kuivumisajat)	50,00%	2

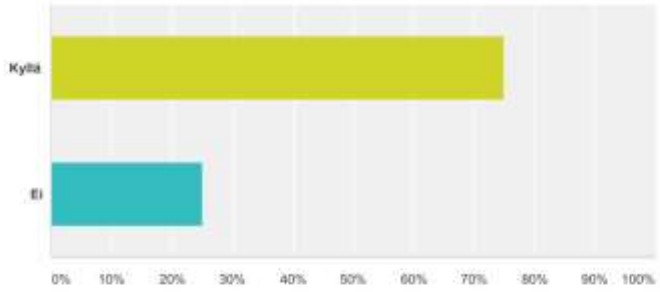
Terve Talo -Kartoitus suppea

Vastaajat yhteensä: 4	

Terve Talo -Kartoitus suppea

Q3 Jos Terve Talo -mallia ei ole käytetty tai se ei ole entuudestaan tuttu, kiinnostaisiko Terve Talo -mallin hyödyntäminen hankkeidenne home-, sisäilma-, kosteus- ja puhtausriskien minimoimiseksi?

Vastattuja: 4 Ohitettuja: 0

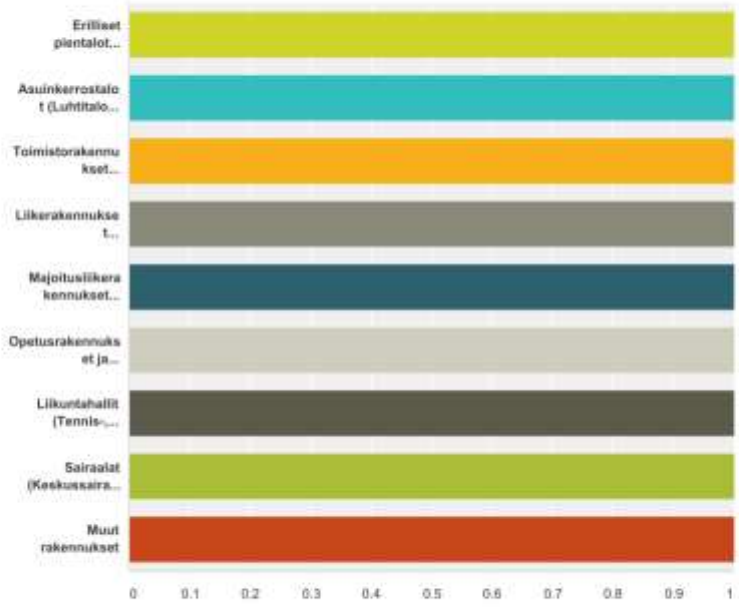


Vastausvaihtoehdot	Vastaukset	
Kyllä	75,00%	3
Ei	25,00%	1
Yhteensä		4

Terve Talo -Kartoitus suppea

Q4 Millaissa rakennuksissa olette hyödyntäneet Terve Talo -kriteereitä

Vastattuja: 9 Ohitettuja: 4



	Huomioidaan yleensä tämän tyyppisissä rakennuksissa	Ei huomioida tämän tyyppisissä rakennuksissa	Yhteensä	Painotettu keskiarvo
Erilliset pientalot (rivi- ja ketjutalot)	0,00% 0	100,00% 9	9	1,00
Asuinkerrostalot (Luhtitalot, muut asuinkerrostalot)	0,00% 0	100,00% 9	9	1,00
Toimistorakennukset (Toimistorakennukset, Terveyskeskukset)	33,33% 3	66,67% 6	9	1,00
Liikerakennukset (Myymälärakennukset, Kirjastot, Museot, Liike- ja tavaratalot, Elokuvateatterit, Myymälähallit, Teatteri)	22,22% 2	77,78% 7	9	1,00
Majoitusliikerakennukset (Hotellit, Asuntolat, Vanhainkodit, Lasten- ja koulukodit, Kehitysvammaisten hotolaitokset)	22,22% 2	77,78% 7	9	1,00
Opetusrakennukset ja päiväkodit (Lasten päiväkodit, Yleissivistävien oppilaitosten rakennukset, Ammatillisten oppilaitosten rakennukset, Korkeakoulurakennukset, Tutkimuslaitosrakennukset)	100,00% 9	0,00% 0	9	1,00
Liikuntahallit (Tennis-, squashhallit, Monitoimihallit)	33,33% 3	66,67% 6	9	1,00

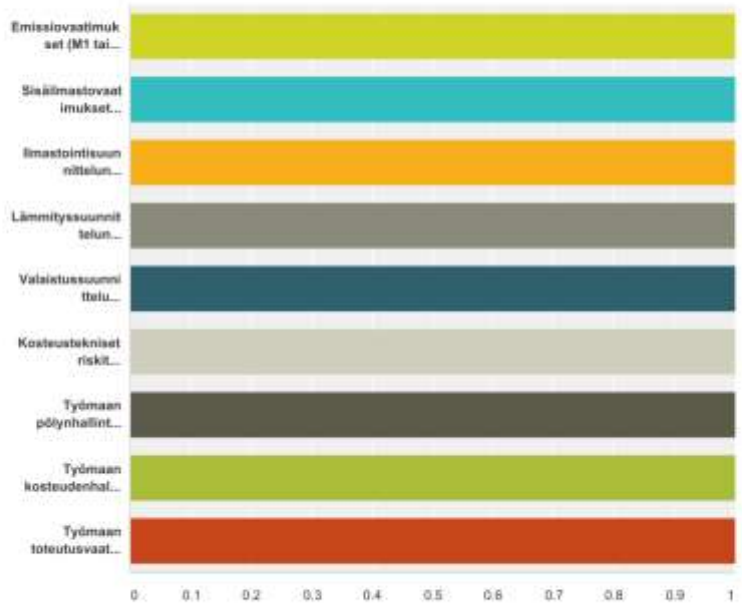
Terve Talo -Kartoitus suppea

Sairaalat (Keskussairaalat, Muut sairaalat)	**66,67%** 6	**33,33%** 3	9	1,00
Muut rakennukset	**0,00%** 0	**100,00%** 9	9	1,00

Terve Talo -Kartoitus suppea

Q5 Mitä seuraavista Terve Talo -kriteereistä olette huomioineet ja millä tasolla hankkeissanne

Vastattuja: 9 Ohitettuja: 4



	Yleinen periaate, Toteutumista ei valvottu	Valvottu osana rakennustöiden valvontaa	Dokumentoitu, Erikseen valvottu toteutusta	Todennettu mittauksin	Yhteensä	Painotettu keskiarvo
Emissiovaatimukset (M1 tai TVOC-mittaukset)	33,33% 3	11,11% 1	33,33% 3	22,22% 2	9	1,00
Sisäilmastovaatimukset (Tavoitearvot, Huonelämpötilat, Laatuvaatimukset, Järjestelmäkaaviot)	11,11% 1	11,11% 1	22,22% 2	55,56% 5	9	1,00
Ilmastointisuunnittelun vaatimukset (Äänitasolaskelmat, Päätelaitteiden sekä IV-peltien esisäätöarvot)	44,44% 4	0,00% 0	33,33% 3	22,22% 2	9	1,00
Lämmitysuunnittelun vaatimukset (Kylmäsillat, ikkunoiden u-arvot, toiminta- ja säätökokeet eri vuodenaikoina)	75,00% 6	12,50% 1	12,50% 1	0,00% 0	8	1,00
Valaistussuunnittelu vaatimukset (Valaisinvaatimukset, UGR, dialux-laskenta)	44,44% 4	0,00% 0	11,11% 1	44,44% 4	9	1,00
Kosteustekniset riskit suunnitteluvaiheessa (Rakennusfysikaaliset tarkastelut)	22,22% 2	0,00% 0	44,44% 4	33,33% 3	9	1,00

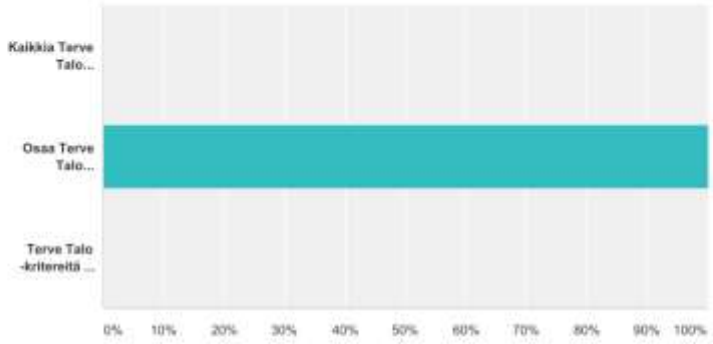
Terve Talo -Kartoitus suppea

Työmaan pölynhallinta vaatimukset (P1)	**0,00%** 0	**11,11%** 1	**22,22%** 2	**66,67%** 6	9	1,00
Työmaan kosteudenhallinnan vaatimukset (Työmaan kosteusriskien tunnistaminen ja hallinta, rakenteiden kuivumisajat)	**0,00%** 0	**0,00%** 0	**0,00%** 0	**100,00%** 9	9	1,00
Työmaan toteutusvaatimukset (Säänsuojat, Materiaalivarastot, Rakenteiden kuivatus)	**0,00%** 0	**33,33%** 3	**44,44%** 4	**22,22%** 2	9	1,00

Terve Talo -Kartoitus suppea

Q6 Miten Terve Talo -kriteeristöä on käytetty hankkeissa yleensä?

Vastattuja: 8 Ohitettuja: 5

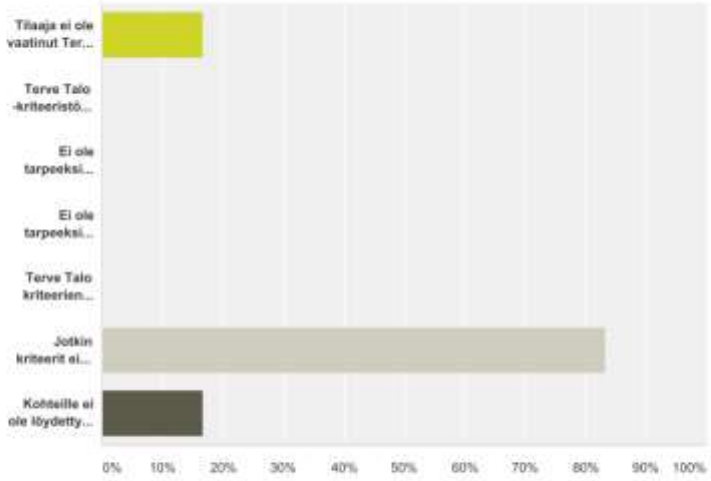


Vastausvaihtoehdot	Vastaukset	
Kaikkia Terve Talo -kriteereitä on käytetty sellaisenaan	0,00%	0
Osaa Terve Talo -kriteereitä on käytetty sovellettuna	100,00%	8
Terve Talo -kritereitä on käytetty ohjaavina	0,00%	0
Yhteensä		8

Terve Talo -Kartoitus suppea

Q7 Mistä johtuu että Terve Talo -kriteereitä ei ole käytetty alkuperäisessä muodossa?

Vastattuja: 6 Ohitettuja: 7



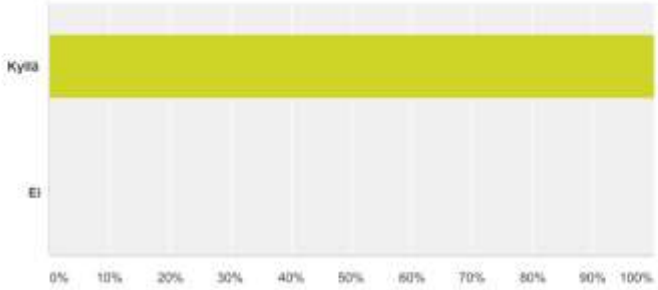
Vastausvaihtoehdot	Vastaukset	
Tilaaja ei ole vaatinut Terve Talo -kriteerien toteuttamista	16,67%	1
Terve Talo -kriteeristön toteuttaminen aiheuttaisi liikaa kustannuksia	0,00%	0
Ei ole tarpeeksi tietoa kriteeristöstä kokonaisuutena	0,00%	0
Ei ole tarpeeksi tietoa yksittäisistä kriteereistä ja niiden toteutuksesta	0,00%	0
Terve Talo kriteerien todentamisessa on ollut epäselvyyttä	0,00%	0
Jotkin kriteerit eivät sovelu sellaisenaan kohteeseen, jonka vuoksi toteutettu sovelletturna	83,33%	5
Kohteille ei ole löydetty Terve Talo -ohjausta tai Valvontaa	16,67%	1
Vastaajat yhteensä: 6		

#	Jonkin muu syy?	Päivämäärä
1	Koulu kohteissa ei ole jäähdytystä joten kriteeristöä on käytetty sovelletturna.	5.2.2017 17:01
2	Ei nähdä tarpeellisena, kokenut suunnitteluryhmä.	5.2.2017 16:46

Terve Talo -Kartoitus suppea

Q8 Onko Terve Talo -kriteeristö mielestäsi tarpeeksi yksiselitteinen ja selkeä?

Vastattuja: 6 Ohitettuja: 7



Vastausvaihtoehdot	Vastaukset	
Kyllä	100,00%	6
Ei	0,00%	0
Yhteensä		6

#	Miten kriteeristöä tulisi mielestäsi kehittää toimivammaksi?	Päivämäärä
1	Ei ole tuoreessa muistissa joten en osaa vastata.	5.2.2017 17:19
2	Kriteeristöä tulee silti täsmentää ja kehittää. Täydellinen noudattaminen mitä ilmeisemmin aiheuttaa merkittävän kustannusnousun.	5.2.2017 16:35

Terve Talo -Kartoitus suppea

Q9 Minkälaisia käytännön haasteita on ilmennyt Terve Talo -hankkeen toteutuksessa?

Vastattuja: 6 Ohitettuja: 7

#	Vastaukset	Päivämäärä
1	Pienten urakoitsijoiden tietämättömyys. Kosteudenhallinnan vaatimuksissa ollut haasteita erityisesti kuivumisaikojen suhteen. Kalustamiseen liittyvät ohjeet tarvittaisiin käyttäjille. P1 toteutuksen taso vaihtelee suuresti urakoitsija kohtaisesti.	5.2.2017 17:21
2	Toimintamallin tuntemattomuus pienille ja keskisuurille urakoitsijoille. Terve Talo vaatimusten saattaminen työntekijöille asti on osittain osoittautunut haastavaksi.	5.2.2017 17:14
3	Rakenteiden kuivumisaikojen kanssa on ollut ongelmia. Puhtaudenhallinnan kanssa on ollut haasteita peruskorjauskohteiden osalta.	5.2.2017 17:03
4	Yksittäisiä kosteita paikkoja on ilmennyt päällysteiden asentamisen jälkeen.	5.2.2017 16:55
5	Kohteiden tyhjänä pito on mahdotonta elenkin koulukohteiden osalta. Muutamia kohteita on jouduttu nuohoamaan ennen käyttöön ottoa.	5.2.2017 16:46
6	Seuranta ja todentaminen on hankalaa	5.2.2017 16:36

Terve Talo -Kartoitus suppea

Q10 Miten Terve Talo -mallia tulisi mielestäsi kehittää, jotta saisitte siitä suuremman hyödyn?

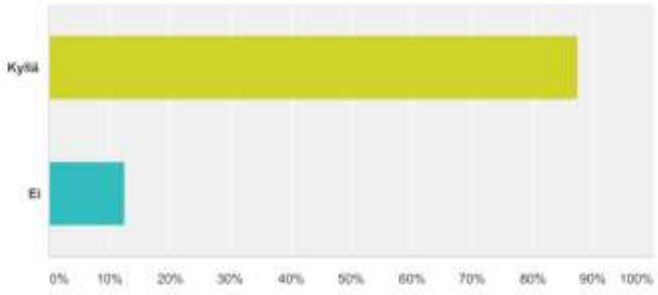
Vastattuja: 6 Ohitettuja: 7

#	Vastaukset	Päivämäärä
1	Urakoitsijoilla pitäisi olla mahdollisuus osallistua perehdytykseen.	5.2.2017 17:21
2	Kriteeristöön liittyvät checklist tyyppiset tarkastuslistat olisivat tarpeen. RT kortit tulee päivittää vastaamaan uusia käytäntöjä.	5.2.2017 17:14
3	Kriteeristön kohdistaminen saneeraus kohteisiin olisi hyödyllistä.	5.2.2017 17:08
4	Kriteeristöä pitäisi kehittää hankesuunnitteluvaiheen vaatimusten osalta.	5.2.2017 17:03
5	Tilaajan valvontaan tulee panostaa enemmän laadun varmistamiseksi.	5.2.2017 16:46
6	Onko tavoitetasoa S1 mahdollista edes saavuttaa ? Suunnittelijat ja tilaajat ja urakoitsijat tulisi muodostaa työryhmä, jonka perusteella kriteeristöä tulee kehittää	5.2.2017 16:36

Terve Talo -Kartoitus suppea

Q11 Kiinnostaisiko Terve Talo -mallin hyödyntäminen alkavissa hankkeissanne home-, sisäilma-, kosteus- ja puhtausriskien minimoimiseksi?

Vastattuja: 8 Ohitettuja: 0



Vastausvaihtoehdot	Vastaukset	
Kyllä	87,50%	7
Ei	12,50%	1
Yhteensä		8