Green@Hospital

web-based energy management system for the optimisation of the energy consumption in hospitals

Work Package 2

Pilot's solution set data analysis

Annex - Deliverable D2.2

Questionnaire analysis and results

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1. Introduction

This Annex to D2.2 Energy saving solution sets reports the complete results of the questionnaires submitted in the four pilot hospitals. For each hospital, for each area and for each subsystem the feelings of different stakeholders have been useful in the final choice of the project energy saving solution sets. While in Chapter 2 of D2.2 just some global results are presented, this annex shows the complete information collected in each pilot.

Different evaluation grids customized for the subsystems analyzed where submitted to different kind of stakeholders and a dedicated area was left to open comments.

The questionnaire scales are reported below.

General thermal comfort in your room	7 – Cold	6	5	4	3	2	1 – Hot
Overall, how satisfied are you with the temperature in your room?	7 – Very satisfied	6	5	4	3	2	1 – Very dissatisfied
How stable is the room temperature during the day?	7 - Stable	6	5	4	3	2	1 - Changes during the day
Air humidity in your room	7 – Too humid	6	5	4	3	2	1 – Too dry
Air odors in your room	7 - Odorless	6	5	4	3	2	1 – Smelly
Overall perception of air quality in your room	7 – Fresh	6	5	4	3	2	1 – Stuffy
I am aware of the control capabilities of the system	7 - Completely agree	6	5	4	3	2	1 - Completely disagree
I know how to adjust the system	7 - Completely agree	6	5	4	3	2	1 - Completely disagree
Overall, I can sufficiently control the environmental conditions in the rooms	7 - Completely agree	6	5	4	3	2	1 - Completely disagree

Table 1 HVAC questionnaire scale

There is enough artificial light in the rooms	7 - Completely agree	6	5	4	3	2	1 - Completely disagree
There is enough daylight in the rooms	7 - Completely agree	6	5	4	3	2	1 - Completely disagree
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	7 – Very satisfied	6	5	4	3	2	1 – Very dissatisfied
I am aware of the control capabilities of the system	7 - Completely agree	6	5	4	3	2	1 - Completely disagree
I know how to adjust the system	7 - Completely agree	6	5	4	3	2	1 - Completely disagree

Table 2 Lighting questionnaire scale

2. AOR

2.1. HVAC

Hematology department – HVAC - Doctors and Nurses

Question	Mean vote doctors	St. deviation doctors	Mean vote nurses	St. deviation nurses
General thermal comfort in your room	1.9	0.9	5.5	1.1
Overall, how satisfied are you with the temperature in your room?	2.6	1.6	3.3	1.3
How stable is the room temperature during the day?	2.6	1.6	1.9	1.5
Air humidity in your room	5.5	1.4	5.2	1.3
Air odors in your room	2.7	1.9	4.3	1.7
Overall perception of air quality in your room	2.9	1.3	4.2	1.7
I am aware of the control capabilities of the system	5.5	0.7	5.7	0.7
I know how to adjust the system	1	0	1	0
Overall, I can sufficiently control the environmental conditions in the rooms	1	0	1	0

Table 3 Hematology department – HVAC - Doctors and Nurses questionnaire results

19 clinicians were interviewed (9 nurses and 10 doctors). The answers collected from nurses are quite different from the ones collected from doctors: doctors' answers are deeply influenced by the bad comfort conditions of the doctors' office, a very crowded room with a lot of internal loads (people, PC's…). Five doctors declared explicitly in their questionnaire that they were referring to their office while answering the questionnaire.

Doctors perceive too high temperature, low air quality and smelly air in their room: clearly cooling and ventilation systems are not sized properly. Nurses on the contrary find air temperature slightly cool. For both stakeholders rooms are just a little bit humid and temperature is not stable. Air temperature instability is affected both by thermal loads and by temperature differences in different rooms.

Below the main characteristics which generate discomfort:

- Low reaction speed of the cooling system
- Temperature differences between different rooms
- Noisy ventilation system
- Low ventilation rates
- Crowded spaces
- Drafts from vents and windows

Both kinds of stakeholders highlight the lack of possibilities to control the environmental conditions of the room.

Hematology department – HVAC – Patients and families

	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
General thermal comfort in your room	4.42	4.38	4.13	4.00	4.77	4.15	5.00
Overall, how satisfied are you with the temperature in your room?	5.96	5.85	6.13	6.09	5.85	6.00	6.00
How stable is the room temperature during the day?	5.78	5.69	6.14	6.60	5.15	6.00	5.33
Air humidity in your room	3.92	4.00	4.00	4.09	3.77	4.15	3.56
Air odors in your room	6.58	6.77	7.00	6.91	6.31	6.77	6.22
Overall perception of air quality in your room	6.33	6.38	6.50	6.45	6.23	6.31	6.22
Overall, I can sufficiently control the environmental conditions in my room	1.29	1.23	1.50	1.18	1.38	1.31	1.33

Table 4 Hematology department – HVAC – Patients and families questionnaire results

24 people interviewed, not all of them answered all the questions so we know for sure that:

- 13 are males and 8 females
- 11 are over 60 and 13 are under 60
- 13 stayed for less than 1 week and 9 stayed for more than 1 week

The overall perception of patients and families concerning indoor environmental condition is better than doctors and nurses one. Patients and families are quite satisfied with temperature and temperature is sufficiently stable in the rooms. They perceive a correct level of humidity and a very good air quality.

The only really negative point is the lack of control of internal conditions: even if the stakeholders are satisfied with the indoor climate conditions they wish to control heating cooling and ventilation system: the psychological effect of having the possibility to control internal climate condition should not be neglected.

Patients and families underlined just one source of discomfort: draft from vents that in some rooms are installed just over the beds.

Oncology department – HVAC - Doctors and Nurses

Question	Mean vote doctors	St. deviation doctors	Mean vote nurses	St. deviation nurses
General thermal comfort in your room	3.5	0.9	3.2	1.5
Overall, how satisfied are you with the temperature in your room?	4.1	1.2	4.2	1.7
How stable is the room temperature during the day?	4.0	1.1	4.6	1.9
Air humidity in your room	4.0	0.0	4.3	1.7
Air odors in your room	5.3	1.5	4.9	1.8
Overall perception of air quality in your room	4.9	0.6	4.4	1.6
I am aware of the control capabilities of the system	3.0	2.2	4.8	1.5
I know how to adjust the system	4.0	2.3	4.7	2.1
Overall, I can sufficiently control the environmental conditions in the rooms	3.5	1.1	4.2	1.1

Table 5 Oncology department – HVAC - Doctors and Nurses questionnaire results

22 clinicians were interviewed in this department (12 nurses, 8 doctors, 2 not known). Doctors' and nurses' perception is very similar: they feel slightly warm and the comfort conditions granted by the HVAC system are sufficient but not very good concerning humidity, air quality and temperature stability.

Even if comfort quality looks acceptable it can be improved and one possible strategy is improving the control available for clinicians. This would avoid also overheating during winter and under cooling during summer highlighted by some clinicians.

Below the main characteristics which generate discomfort in the oncology department:

- Low reaction speed of the cooling system
- Hot window and wall surfaces
- Temperature differences between different rooms
- Drafts from vents and windows

Oncology department – HVAC – Patients and families

	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
General thermal comfort in your room	4.3	4.2	4.4	4.5	4.4	4.4	4.2
Overall, how satisfied are you with the temperature in your room?	5.7	5.8	5.7	6.1	5.6	5.5	6.1
How stable is the room temperature during the day?	6.3	6.1	6.4	6.3	6.2	6.2	6.5
Air humidity in your room	4.1	4.1	4.0	4.1	4.0	4.1	4.1
Air odors in your room	6.4	6.5	6.2	6.4	6.5	6.3	6.7
Overall perception of air quality in your room	5.5	5.4	5.6	5.5	5.6	5.5	5.4
Overall, I can sufficiently control the environmental conditions in my room	4.4	5.8	4.0	4.2	4.7	3.8	5.5

Table 6 Oncology department – HVAC – Patients and families questionnaire results

52 people interviewed, not all of them answered all the questions so we know for sure that:

- 16 are males and 24 females
- 26 are over 60 and 23 are under 60
- 29 stayed for less than 1 week and 23 stayed for more than 1 week

Patients and families satisfaction concerning indoor environmental condition is better than doctors and nurses one. Patients and families are quite satisfied with temperature and temperature is sufficiently stable in the rooms. They perceive a correct level of humidity and a good air quality.

The scores collected in the oncology department are quite similar to the scores collected in the hematology department. The main deviation concerns air quality (better perceived in the oncology department) and temperature stability (better perceived in the hematology department).

The need for higher control capabilities does not seem to be so important in the oncology department like it is in the hematology department.

Below the main characteristics which generate discomfort in the oncology department:

- Low reaction speed of the cooling system
- Drafts from vents and windows

Oncology pharmacy – HVAC – Pharmacists and nurses

Question	Mean vote pharmacists	St. deviation pharmacists	Mean vote nurses	St. deviation nurses
General thermal comfort in your room	5.3	0.7	2.5	0.6
Overall, how satisfied are you with the temperature in your room?	6.0	0.7	2.5	0.6
How stable is the room temperature during the day?	5.7	2.8	3.2	1.1
Air humidity in your room	5.0	0.0	4.7	0.6
Air odors in your room	6.0	2.1	4.0	2.5
Overall perception of air quality in your room	6.0	0.7	4.7	2.5
I am aware of the control capabilities of the system	3.0	0.0	3.7	3.5
I know how to adjust the system	3.0	0.0	3.5	2.9
Overall, I can sufficiently control the environmental conditions in the rooms	3.0	0.0	2.2	0.0

Table 7 Oncology pharmacy – HVAC – Pharmacists and nurses questionnaire results

5 people were interviewed in this area (2 pharmacists, 3 nurses). Pharmacists and nurses work in different areas: that's why the perception of comfort conditions is so different.

Pharmacists, even if they feel the environment slightly cold and humid, are satisfied about room temperature. Air temperature is almost stable and air quality is quite fresh.

Below the main characteristics which generate discomfort in pharmacists' area:

- Low reaction speed of the cooling system
- Temperature differences between different rooms
- Drafts due to wrong position of vents

Nurses, from their side, work in a different room and they have to wear special clothing. Furthermore in their room there are a lot of thermal loads due to people and medical equipment. The air conditioning system does not seem to fulfill the needed comfort requirements: 20°C are needed because of drugs conservation requirements and technicians' clothing while there are usually 25°C in the room and 27°C under the hood. Air

temperature level and stability are the worst parameters but also air quality and air odors score low.

Below the main characteristics which generate discomfort in nurses' area:

- Low reaction speed of the cooling system
- Drafts from vents and ceiling

Both stakeholders' categories feel the necessity to improve the control capabilities of the HVAC system.

2.2. Lighting

Hematology department – lighting - Doctors and Nurses

Question	Mean vote doctors	St. deviation doctors	Mean vote nurses	St. deviation nurses
There is enough artificial light in the rooms	4.5	1.9	5.7	2.1
There is enough daylight in the rooms	3.1	2.5	3.5	2.1
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	3.4	1.8	4.5	2.0
I am aware of the control capabilities of the system	2.8	1.5	3.8	1.8
I know how to adjust the system	2.4	1.7	4.2	1.8

Table 8 Hematology department – lighting - Doctors and Nurses questionnaire results

20 clinicians were interviewed (9 nurses and 11 doctors). The answers collected from nurses are quite different from the ones collected from doctors: five doctors declared explicitly in their questionnaire that they were referring to their office while answering the questionnaire.

However questionnaires highlight a sufficient level of artificial lighting while natural lighting is not sufficient. Visual comfort should be improved in doctors' room. Lighting control is possible just via a switchboard which is not easily accessible: that's why clinicians are not aware about control capabilities and wish to have more control on artificial lighting.

Some votes about natural lighting have been probably influenced by broken shadings: this fact was highlighted by 4 nurses.

Moreover a good advice was collected from the open comments: lights should be switched off during night in the day hospital area where often they remain switched on.

Hematology department – lighting – Patients and families

	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
There is enough artificial light in your room	6.6	6.8	6.2	6.8	6.5	6.6	6.7
There is enough daylight in your room	5.8	5.9	5.5	6	5.7	6.1	4.8
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	6.1	6.2	5.9	6.25	6.1	6.2	6.2

Table 9 Hematology department – lighting – Patients and families questionnaire results

24 people interviewed, not all of them answered all the questions so we know for sure that:

- 13 are males and 8 females
- 11 are over 60 and 13 are under 60
- 13 stayed for less than 1 week and 9 stayed for more than 1 week

The overall perception of patients and families concerning natural and artificial lighting condition is better than doctors and nurses one. Patients and families are quite satisfied both with artificial lighting and natural lighting. The reason for a lower satisfaction with natural lighting is due to the limited possibility to control it: 30% of the interviewed people wish to have an improved control on natural lighting.

Oncology department – lighting - Doctors and Nurses

Question	Mean vote doctors	St. deviation doctors	Mean vote nurses	St. deviation nurses
There is enough artificial light in the rooms	5.6	1.3	5.1	1.2
There is enough daylight in the rooms	4.0	2.3	4.8	1.1
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	4.3	1.2	4.6	1.2
I am aware of the control capabilities of the system	4.0	1.8	4.3	1.0
I know how to adjust the system	5.1	1.8	4.5	1.5

Table 10 Oncology department – lighting - Doctors and Nurses questionnaire results

21 clinicians were interviewed in this department (11 nurses, 8 doctors, 2 not known). Doctors' and nurses' perception is quite similar: they agree that the artificial light level is satisfactory and that the daylight is sufficient. The difference of score between artificial and natural light is more evident for doctors than for nurses: this is probably due to the different job and different rooms where doctors usually stay.

Although lighting control is possible just via a switchboard which is not easily accessible like in the Hematology department the perception of the control capabilities is more positive: this is probably due to the overall positive perception of the lighting.

Clinicians added some open comments about how to improve energy efficiency:

- to reduce the luminance level during night
- to install LED lamps

Oncology department – lighting – Patients and families

	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
There is enough artificial light in your room	6.4	1.2	6.3	6.3	6.5	6.4	6.4
There is enough daylight in your room	6.3	1.3	6.6	6.1	6.44	6.1	6.3
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	5.9	1.2	6.1	5.8	6.0	6.0	5.9

Table 11 Oncology department – lighting – Patients and families questionnaire results

52 people interviewed, not all of them answered all the questions so we know for sure that:

- 16 are males and 24 females
- 26 are over 60 and 23 are under 60
- 29 stayed for less than 1 week and 23 stayed for more than 1 week

Like for thermal comfort conditions also for lighting the perception of patients and families is better the clinicians' one. Both artificial lighting and natural lighting levels are judged excellent by users. Just 20% of them wish to have improved control capabilities.

Oncology pharmacy – lighting – Pharmacists and nurses

Question	Mean vote pharmacists	St. deviation pharmacists	Mean vote nurses	St. deviation nurses
There is enough artificial light in the rooms	6.0	1.4	7.0	0.0
There is enough daylight in the rooms	3.5	3.5	1.7	0.6
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	6.5	0.7	4.3	3.0
I am aware of the control capabilities of the system	4.0	4.2	5.7	2.3
I know how to adjust the system	4.0	4.2	5.0	3.5

Table 12 Oncology pharmacy – lighting – Pharmacists and nurses questionnaire results

5 people were interviewed in this area (2 pharmacists, 3 nurses). Although pharmacists and nurses work in different areas the perception about daylight is similar: artificial light complies very well with clinicians' requirements while natural light is not sufficient because the oncology pharmacy is in a basement floor and there are no windows.

Even if artificial lights control is centralized clinicians seem to be satisfied with the control capabilities but checking the standard deviation of questionnaire results we understand that there is not a common agreement about that.

However checking the open answers it is clear the wish to have more control capabilities. In details:

- Switches in each areas are needed
- The possibility to soften background light would be helpful
- Task lights to help reading labels would be useful

3. HVN

3.1. HVAC

Emergency department – HVAC – Doctors and Nurses

Question	Mean vote doctors	St. deviation doctors	Mean vote nurses	St. deviation nurses
General thermal comfort in your room	3,7	0,6	3,4	0,9
Overall, how satisfied are you with the temperature in your room?	3,7	0,6	4,0	0,7
How stable is the room temperature during the day?	3,3	1,2	4,4	0,9
Air humidity in your room	3,7	1,5	4,2	1,3
Air odors in your room	1,7	1,2	2,2	2,7
Overall perception of air quality in your room	1,7	1,2	2,2	1,3
I am aware of the control capabilities of the system	3,0	1,7	3,8	0,4
I know how to adjust the system	3,3	1,2	3,0	1,2
Overall, I can sufficiently control the environmental conditions in the rooms	2,7	1,5	3,5	0,6

Table 13 AHU Free-cooling – HVAC – Doctors and Nurses questionnaire results

8 clinicians were interviewed (5 nurses and 3 doctors).

The interviewees are not completely satisfied with their comfort conditions. Air quality seems to be the main problem, both from “close” and “open” answers concerning odors, air quality and ventilation. Both doctors and nurses pointed out problems with ventilation (noise, draft from the ceiling) and with window surface temperature (mean radiant temperature different from air temperature).

They also noticed a smell of food that is wished to be removed. This problem may be linked to the ventilation system design.

The interviewees partially know how to manage the systems and would prefer to have the possibility to control more parameters concerning environmental comfort.

Surgery theaters– HVAC – Doctors and Nurses

Question	Mean vote doctors	St. deviation doctors	Mean vote nurses	St. deviation nurses
How well does the system meet the temperature and humidity requirements (the ones you wrote above)?	2,5	2,1	2,0	1,7
How well does the system meet the air quality requirements (the ones you wrote above)?	2,5	2,1	1,5	0,7
I am aware of the control capabilities of the system	2,5	2,1	4,3	2,5
I know how to adjust the system	2,5	2,1	5,7	2,3
Overall, I can sufficiently control the environmental conditions in the surgery theater (i.e., the control capabilities of the system are enough)	1,0	0,0	1,3	0,6

Table 14 Surgery theater– HVAC – Doctors and Nurses questionnaire results

5 clinicians were interviewed (3 nurses and 2 doctors). Even if the interviewee population is very little, the summary table is reported for completeness and coherence with the whole analysis.

Doctors and nurses are not satisfied with the conditions and the possibilities of adjusting the parameters; nurses show more familiarity with system's adjustment, even complaining about the lack of control possibility.

The questionnaires' results don't contain open comments or more indications on the systems that deserve more importance than others, so it is not possible to make further considerations.

4. SGH

4.1. HVAC

Room – HVAC – Doctors and Nurses

Question	Mean vote doctors	St. deviation doctors	Mean vote nurses	St. deviation nurses
General thermal comfort in your room	3,6	1,1	5,0	1,4
Overall, how satisfied are you with the temperature in your room?	3,0	0,6	3,3	1,0
How stable is the room temperature during the day?	3,1	0,8	3,1	0,8
Air humidity in your room	3,9	0,6	3,9	0,6
Air odors in your room	3,2	0,9	3,1	0,9
Overall perception of air quality in your room	3,3	0,8	3,2	0,8
I am aware of the control capabilities of the system	3,1	0,6	3,3	0,9
I know how to adjust the system	3,1	0,6	3,3	1,0
Overall, I can sufficiently control the environmental conditions in the rooms	4,0	0,4	4,1	0,7

Table 15 Room – HVAC – Doctors and Nurses questionnaire results

31 clinicians were interviewed (22 nurses and 9 doctors).

The interviewees were partially satisfied with their condition in rooms; the nurses show higher satisfaction regarding general comfort.

The ventilation seems to be the main problem as verified from both “close” and “open” answers concerning air quality. Both doctors and nurses pointed out the problems from mechanical ventilation (noise, draft from the ceiling) and with window surface temperature (mean radiant temperature different from air temperature).

As for local regulation, some doctors and nurses noticed that the system does not respond quickly to the local changes and that their room is hotter than other areas.

Some of them requested local control in order to be able to regulate their indoor environment more effectively.

Room – HVAC – Patients and families

The questionnaires filled by patients and families were divided according to the different departments that they were hosted. For completeness the single tables have been reported with the indication of the interviewed population and some comments.

A-Pathology

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
General thermal comfort in your room	4,0	4,0	4,0	4,0	4,0	4,2	3,8
Overall, how satisfied are you with the temperature in your room?	6,0	6,1	5,7	6,0	6,0	7,0	5,0
How stable is the room temperature during the day?	3,5	4,3	1,7	1,0	3,8	3,4	3,6
Air humidity in your room	3,9	4,1	3,3	4,0	3,9	4,0	3,8
Air odors in your room	4,8	5,1	4,0	6,0	4,7	5,4	4,2
Overall perception of air quality in your room	5,7	6,3	4,3	7,0	5,6	6,4	5,0
Overall, I can sufficiently control the environmental conditions in the rooms	6,6	6,4	7,0	7,0	6,6	6,6	6,6

Table 16 Room – HVAC – Patients and families - A Pathology questionnaire results

At A Pathology 10 people were interviewed of whom 7 were male and 3 were female. The main comments that were recorded were:

- The draft from windows affects the thermal comfort considerably.
- The outdoor temperature and in general the climatic conditions, temperature and humidity have significant influence in room thermal and ventilation comfort.
- The majority of the people highlighted the effectiveness of ventilation system.

A-Surgery

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
General thermal comfort in your room	3,3	3,0	4,0	2,0	4,0	4,0	3,0
Overall, how satisfied are you with the temperature in your room?	6,0	7,0	4,0	7,0	5,5	7,0	5,5
How stable is the room temperature during the day?	5,0	6,0	3,0	5,0	5,0	7,0	4,0
Air humidity in your room	4,0	4,0	4,0	4,0	4,0	4,0	4,0
Air odors in your room	7,0	7,0	7,0	7,0	7,0	7,0	7,0
Overall perception of air quality in your room	6,3	6,5	6,0	6,0	6,5	7,0	6,0
Overall, I can sufficiently control the environmental conditions in the rooms	7,0	7,0	7,0	7,0	7,0	7,0	7,0

Table 17 Room – HVAC – Patients and families - A surgery questionnaire results

At A Surgery 3 people were interviewed of whom 2 were male and 1 was female. The main comments that were recorded were:

- The draft from windows affects the thermal comfort considerably.
- The outdoor temperature and in general the climatic conditions, temperature and humidity have significant influence in room thermal and ventilation comfort.

- The majority of the people highlighted the effectiveness of cooling and ventilation system.

B-Pathology

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
General thermal comfort in your room	3,8	3,3	4,2	3,7	3,8	4,6	3,1
Overall, how satisfied are you with the temperature in your room?	6,2	6,0	6,3	5,8	6,5	6,4	6,0
How stable is the room temperature during the day?	4,6	4,7	4,5	4,0	5,2	4,8	4,4
Air humidity in your room	3,8	3,8	3,8	3,8	3,8	3,8	3,9
Air odors in your room	4,5	4,5	4,5	4,7	4,3	4,4	4,6
Overall perception of air quality in your room	5,4	6,3	4,5	5,7	5,2	4,2	6,3
Overall, I can sufficiently control the environmental conditions in the rooms	5,9	5,7	6,2	6,2	5,7	6,0	5,9

Table 18 Room – HVAC – Patients and families - B Pathology questionnaire results

At this department 12 people were interviewed of whom 6 were male and 6 were female. The main comments that were recorded were:

- The draft from windows affects the thermal comfort considerably.
- The outdoor temperature and in general the climatic conditions, temperature and humidity have significant influence in room thermal and ventilation comfort.
- The majority of the people highlighted the effectiveness of cooling and ventilation system.

Gynecological

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
General thermal comfort in your room	4,2	4,0	4,3	--	4,2	4,2	4,0
Overall, how satisfied are you with the temperature in your room?	6,2	5,6	6,7	--	6,2	6,2	6,0
How stable is the room temperature during the day?	3,1	3,4	2,8	--	3,1	2,7	5,0
Air humidity in your room	4,0	4,0	4,0	--	4,0	4,0	4,0
Air odors in your room	5,6	5,4	5,8	--	5,6	5,3	7,0
Overall perception of air quality in your room	5,1	4,6	5,5	--	5,1	5,4	3,5
Overall, I can sufficiently control the environmental conditions in the rooms	6,9	6,8	7,0	--	6,9	7,0	6,5

Table 19 Room – HVAC – Patients and families - Gynecological questionnaire results

At this department 11 people were interviewed of whom 5 were male and 6 were female. The main comments that were recorded were:

- The draft from windows affects the thermal comfort considerably.
- The outdoor temperature and in general the climatic conditions, temperature and humidity have significant influence in room thermal and ventilation comfort.
- The window surface temperature (mean radiant temperature different from air temperature), has influence in room's thermal comfort.
- The majority of the people highlighted the effectiveness of ventilation system.

Cardiology

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
General thermal comfort in your room	3,8	3,8	4,0	4,0	3,5	4,0	3,8
Overall, how satisfied are you with the temperature in your room?	6,0	5,8	7,0	7,0	4,0	7,0	5,5
How stable is the room temperature during the day?	3,0	3,4	1,0	2,3	4,5	3,5	2,8
Air humidity in your room	4,0	4,0	4,0	4,0	4,0	3,5	4,3
Air odors in your room	4,5	4,6	4,0	4,3	5,0	5,5	4,0
Overall perception of air quality in your room	5,5	5,4	6,0	6,0	4,5	6,0	5,3
Overall, I can sufficiently control the environmental conditions in the rooms	5,3	5,0	7,0	5,0	6,0	4,0	6,0

Table 20 Room – HVAC – Patients and families - Cardiology questionnaire results

At this department 6 people were interviewed of whom 5 were male and 1 was female. The main comments that were recorded were:

- The draft from windows affects the thermal comfort considerably.
- The outdoor temperature and in general the climatic conditions, temperature and humidity have significant influence in room thermal and ventilation comfort.
- The window surface temperature (mean radiant temperature different from air temperature), has influence in room's thermal comfort.
- The majority of the people highlighted the effectiveness of cooling system.

Orthopedic

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
General thermal comfort in your room	3,7	4,7	2,8	3,7	3,8	4,0	3,7
Overall, how satisfied are you with the temperature in your room?	5,5	6,2	5,2	6,0	5,5	5,0	5,9
How stable is the room temperature during the day?	4,4	4,8	3,3	3,5	4,4	1,7	4,9
Air humidity in your room	4,0	3,8	4,2	4,0	4,0	4,0	4,0
Air odors in your room	4,7	4,5	4,3	4,8	4,3	6,0	3,9
Overall perception of air quality in your room	5,5	5,8	5,5	6,0	5,5	6,3	5,4
Overall, I can sufficiently control the environmental conditions in the rooms	5,1	4,7	5,5	6,0	4,6	7,0	4,4

Table 21 Room – HVAC – Patients and families - Orthopedic questionnaire results

At Orthopedic department 12 people were interviewed of whom 6 were male and 6 were female. The main comments that were recorded were:

- The draft from windows affects the thermal comfort considerably.
- The outdoor temperature and in general the climatic conditions, temperature and humidity have significant influence in room thermal and ventilation comfort.
- The ventilation system is too noisy.
- The majority of the people highlighted the effectiveness of ventilation system.

Urology

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
General thermal comfort in your room	3,7	3,8	3,6	3,8	3,5	3,9	3,0
Overall, how satisfied are you with the temperature in your room?	5,4	6,5	4,6	5,4	5,5	5,3	6,0
How stable is the room temperature during the day?	3,1	3,8	2,6	3,6	2,5	3,7	1,0
Air humidity in your room	4,0	4,3	3,8	4,4	3,5	4,3	3,0
Air odors in your room	3,8	4,0	3,6	3,8	3,8	4,0	3,0
Overall perception of air quality in your room	5,6	5,5	5,6	5,8	5,3	5,4	6,0
Overall, I can sufficiently control the environmental conditions in the rooms	6,3	6,3	6,4	6,4	6,3	6,6	5,5

Table 22 Room – HVAC – Patients and families - Urology questionnaire results

At this department 9 people were interviewed of whom 4 were male and 5 were female. The main comments that were recorded were:

- The draft from windows affects the thermal comfort considerably.
- The outdoor temperature and in general the climatic conditions, temperature and humidity have significant influence in room thermal and ventilation comfort.
- The window surface temperature (mean radiant temperature different from air temperature), has influence in room's thermal comfort.
- The majority of the people highlighted the effectiveness of cooling ventilation system.

Pediatric

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
General thermal comfort in your room	3,8	3,0	4,0	3,0	4,0	4,0	3,5
Overall, how satisfied are you with the temperature in your room?	6,0	6,0	6,0	6,0	6,0	6,0	6,0
How stable is the room temperature during the day?	2,2	1,0	2,5	1,0	2,5	3,0	1,0
Air humidity in your room	4,2	4,0	4,3	4,0	4,3	4,3	4,0
Air odors in your room	5,6	4,0	6,0	4,0	6,0	6,0	5,0
Overall perception of air quality in your room	5,8	6,0	5,8	6,0	5,8	6,0	5,5
Overall, I can sufficiently control the environmental conditions in the rooms	6,8	7,0	6,8	7,0	6,8	7,0	6,5

Table 23 Room – HVAC – Patients and families - Pediatric questionnaire results

At Pediatric department 5 people were interviewed of whom 1 was male and 4 were female. The main comments that were recorded were:

- The draft from windows affects the thermal comfort considerably.
- The outdoor temperature and in general the climatic conditions, temperature and humidity have significant influence in room thermal and ventilation comfort.
- The ventilation system is too noisy.
- The majority of the people highlighted the effectiveness of ventilation system.

Pneumology

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
General thermal comfort in your room	5,0	4,0	5,3	--	5,0	5,3	4,0
Overall, how satisfied are you with the temperature in your room?	6,3	4,0	7,0	--	6,3	6,0	7,0
How stable is the room temperature during the day?	3,3	2,0	3,7	--	3,3	3,3	3,0
Air humidity in your room	4,0	4,0	4,0	--	4,0	4,0	4,0
Air odors in your room	5,0	7,0	4,3	--	5,0	4,3	7,0
Overall perception of air quality in your room	5,5	6,0	5,3	--	5,5	5,3	6,0
Overall, I can sufficiently control the environmental conditions in the rooms	7,0	7,0	7,0	--	7,0	7,0	7,0

Table 24 Room – HVAC – Patients and families - Pneumology questionnaire results

At this department 4 people were interviewed of whom 1 was male and 3 were female. The main comments that were recorded were:

- The outdoor temperature and in general the climatic conditions, temperature and humidity have significant influence in room thermal and ventilation comfort.
- The majority of the people highlighted the effectiveness of ventilation system.

4.2. Lighting

Room – lighting – Doctors and Nurses

Question	Mean vote doctors	St. deviation doctors	Mean vote nurses	St. deviation nurses
There is enough artificial light in the rooms	5,7	1,5	5,1	2,1
There is enough daylight in the rooms	6,0	1,3	6,0	1,6
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	4,8	1,6	5,2	1,7
I am aware of the control capabilities of the system	4,3	1,5	4,2	1,9
I know how to adjust the system	4,1	1,8	4,2	1,9

Table 25 Room – lighting – Doctors and Nurses questionnaire results

For this part of questionnaire total 31 clinicians were interviewed (22 nurses and 9 doctors). The results show medium-high satisfaction with visual comfort both for doctors and nurses; the answers where similar between the two groups of people. Some of them would like to have bigger windows, with sunshade. In general more people would want to have more control on artificial lighting, rather than daylight control.

Room – Lighting – Patients and families

The questionnaires filled by patients and families have been recorded divided per departments. For completeness the single tables have been reported with the indication of the interviewed population and some comments.

A-Pathology

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
There is enough artificial light in the rooms	6,2	6,0	6,7	7,0	6,1	6,4	6,0
There is enough daylight in the rooms	6,3	6,0	7,0	7,0	6,2	6,6	6,0
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	6,3	6,1	6,7	7,0	6,2	6,6	6,0

Table 26 Room – Lighting – Patients and families - A pathology - questionnaire results

At this department 10 people were interviewed of whom 7 were male and 3 were female. The main comments that were recorded were:

- There is general satisfaction with their visual comfort.
- There is interest in more control on daylight probably with shades.

A-Surgery

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
There is enough artificial light in the rooms	6,0	7,0	4,0	7,0	5,5	7,0	5,5
There is enough daylight in the rooms	7,0	7,0	7,0	7,0	7,0	7,0	7,0
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	5,7	5,0	7,0	3,0	7,0	7,0	5,0

Table 27 Room – Lighting – Patients and families - A surgery - questionnaire results

At this department 3 people were interviewed of whom 2 were male and 1 was female. The main comments that were recorded were:

- There is interest in more control on daylight probably with shades.
- Dissatisfaction with their visual comfort because the daylight is very strong in the room and there are not shades.

B-Pathology

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
There is enough artificial light in the rooms	5,5	5,7	5,3	4,8	6,2	5,0	5,9
There is enough daylight in the rooms	6,9	6,8	7,0	7,0	6,8	7,0	6,9
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	3,7	4,2	3,2	2,2	5,2	3,4	3,9

Table 28 Room – Lighting – Patients and families - B Pathology - questionnaire results

At this department 12 people were interviewed of whom 6 were male and 6 were female. The main comments that were recorded were:

- There is general satisfaction more with their natural than their artificial light.
- Dissatisfaction with their visual comfort because the daylight is very strong in the room and there are not shades.

Gynecological

Question	Mean value	Mean value Male	Mean Value Femal e	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
There is enough artificial light in the rooms	6,4	5,6	7,0	--	6,4	6,6	5,5
There is enough daylight in the rooms	6,5	6,2	6,8	--	6,5	6,7	6,0
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	3,5	4,8	2,5	--	3,5	3,7	3,0

Table 29 Room – Lighting – Patients and families - Gynecological - questionnaire results

At Gynecological department 11 people were interviewed of whom 5 were male and 6 were female. The main comments that were recorded were:

- There is not satisfaction with their visual comfort without specifying the reasons.
- Daylight is very important and would want more possibility of system's control.

Cardiology

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
There is enough artificial light in the rooms	7,0	7,0	7,0	7,0	7,0	7,0	7,0
There is enough daylight in the rooms	6,8	6,8	7,0	6,8	7,0	6,5	7,0
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	6,0	6,4	4,0	6,3	5,5	7,0	5,5

Table 30 Room – Lighting – Patients and families - Cardiology - questionnaire results

At this department 6 people were interviewed of whom 5 were male and 1 was female.

The main comments that were recorded were:

- There is not satisfaction with their visual comfort without specifying the reasons.
- The preference on daylight or artificial lighting control is the same.

Orthopedic

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
There is enough artificial light in the rooms	5,6	6,0	5,2	5,3	5,8	5,7	5,6
There is enough daylight in the rooms	6,3	6,2	6,5	6,5	6,3	7,0	6,1
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	5,1	6,0	4,2	4,0	5,6	4,0	5,4

Table 31 Room – Lighting – Patients and families - Orthopedic - questionnaire results

At this department 12 people were interviewed of whom 6 were male and 6 were female. The main comments that were recorded were:

- There is general satisfaction with their visual comfort.
- Daylight is very important and would want more possibility of system's control.

Urology

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
There is enough artificial light in the rooms	5,9	6,2	5,5	6,2	5,5	5,6	7,0
There is enough daylight in the rooms	6,9	6,8	7,0	6,8	7,0	6,9	7,0
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	5,7	5,8	5,5	5,6	5,8	5,6	6,0

Table 32 Room – Lighting – Patients and families - Urology - questionnaire results

At this department 9 people were interviewed of whom 5 were male and 4 were female. The main comments that were recorded were:

- There is general satisfaction with their visual comfort.
- Artificial lighting is very important and would want more possibility of system's control.

Pediatric

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
There is enough artificial light in the rooms	7,0	7,0	7,0	--	7,0	7,0	7,0
There is enough daylight in the rooms	6,2	7,0	6,0	--	6,2	5,7	7,0
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	3,2	2,0	3,5	--	3,2	4,3	1,5

Table 33 Room – Lighting – Patients and families - Pediatric - questionnaire results

At this department 5 people were interviewed of whom 1 was male and 4 were female. The main comments that were recorded were:

- There is enough artificial and natural light, even if they are not totally satisfied with their general visual comfort.
- Daylight is very important and would want more possibility of system's control.

Pneumology

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
There is enough artificial light in the rooms	6,8	6,0	7,0	--	6,8	6,7	7,0
There is enough daylight in the rooms	7,0	7,0	7,0	--	7,0	7,0	7,0
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	5,8	7,0	5,3	--	5,8	5,3	7,0

Table 34 Room – Lighting – Patients and families - Pneumology - questionnaire results

At this department 4 people were interviewed of whom 1 was male and 3 were female. The main comments that were recorded:

- Daylight is very important and would want more possibility of system's control
- There is enough artificial and natural light, and that they are satisfied with their general visual comfort.

5. HML

5.1. HVAC

Room– HVAC – Doctors and Nurses

Question	Mean vote doctors	St. deviation doctors	Mean vote nurses	St. deviation nurses
General thermal comfort in your room	3,8	1,2	3,7	1,4
Overall, how satisfied are you with the temperature in your room?	5,1	1,6	4,1	1,0
How stable is the room temperature during the day?	4,0	1,9	3,6	1,7
Air humidity in your room	3,9	0,6	3,7	0,7
Air odors in your room	4,8	1,5	4,6	1,8
Overall perception of air quality in your room	5,6	1,2	4,3	1,6
I am aware of the control capabilities of the system	4,6	1,4	3,7	1,5
I know how to adjust the system	2,6	1,5	2,3	1,5
Overall, I can sufficiently control the environmental conditions in the rooms	2,3	1,5	2,0	1,1

Table 35 Room– HVAC – Doctors and Nurses questionnaire results

44 clinicians were interviewed (36 nurses and 8 doctors). The answers collected from nurses are quite different from the ones collected from doctors: doctors often observed that the heating/cooling system does not respond very quickly at their changes in thermostat settings.

Nurses are focused on room temperatures and find them hotter than desired (13 answers, while just 3 complain about too cold room temperature). A nurse who finds the room colder than desired, noted that the discomfort situation occurs most of all during the night.

In a choice among heating, cooling and ventilation, many of the interviewees consider all of them very important and to be improved as for the possibility of control, with a slight preponderance of cooling control.

Doctors highlight a good temperature and air quality in the room and find humidity and smells acceptable. As mentioned before, they are not satisfied of the system control possibilities, probably due to lack of awareness of the systems.

As respect to doctors, the nurses have the same feelings, but showing a bit less satisfaction.

Below the main characteristics which generate discomfort:

- Low reaction speed of the cooling system
- Temperature differences between different rooms
- Drafts from vents and windows

Both stakeholders highlight the lack of possibilities to control the environmental conditions of the room.

Room – HVAC – Patients and families

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean Value > 1 week
General thermal comfort in your room	4,2	5,1	3,9	4,2	4,2	4,2	4,3
Overall, how satisfied are you with the temperature in your room?	4,6	5,5	4,3	4,9	4,1	4,6	4,6
How stable is the room temperature during the day?	4,8	5,8	4,5	5,3	3,8	4,8	4,9
Air humidity in your room	4,0	3,9	4,1	4,0	4,2	4,5	3,9
Air odors in your room	5,5	5,6	5,4	5,6	5,2	5,1	5,6
Overall perception of air quality in your room	5,4	5,8	5,3	5,5	5,3	5,0	5,6
Overall, I can sufficiently control the environmental conditions in the rooms	3,8	3,9	3,8	3,6	4,4	4,5	3,6

Table 36 Room – HVAC – Patients and families questionnaire results

43 people interviewed, not all of them answered all the questions so we know for sure that:

- 12 are males and 31 females
- 30 are over 60 and 13 are under 60
- 12 stayed for less than 1 week and 31 stayed for more than 1 week

The perception of patients and families concerning the general thermal comfort is overall good, with no variation on age and length of hospital stay; males perceive a colder sensation than women.

They perceive a correct level of humidity and a quite good air quality.

The lowest votes have been recorded in the environmental conditions control, the interviewees complained about room temperature and slow system response in the open

questions. Few of them also noticed that the ventilation system is too noisy, but considering this system very important to be controlled together with cooling one. According to the stakeholders, these two systems deserve big attention and improvements in terms of control.

Surgery theater– HVAC – Doctors and Nurses

Question	Mean vote doctors	St. deviation doctors	Mean vote nurses	St. deviation nurses
How well does the system meet the temperature and humidity requirements (the ones you wrote above)?	3,9	1,7	5,1	0,8
How well does the system meet the air quality requirements (the ones you wrote above)?	3,9	1,7	5,1	0,8
I am aware of the control capabilities of the system	3,2	1,8	4,8	1,2
I know how to adjust the system	1,8	0,8	3,9	2,3
Overall, I can sufficiently control the environmental conditions in the surgery theater (i.e., the control capabilities of the system are enough)	2,8	1,5	3,6	1,8

Table 37 Surgery theater– HVAC – Doctors and Nurses questionnaire results

44 clinicians were interviewed (36 nurses and 8 doctors). The answers collected from nurses are quite different from the ones collected from doctors: doctors have in general worse opinions on quality and often observed that the control system does not regulate the temperature as expected.

Nurses' answers shown more satisfaction in the "close" ones; nevertheless even they observed instability in temperature control and late error detection in the comments.

As for air quality in surgery theaters, doctors and nurses consider very important air renovation and the unidirectional flow. Some of them are also focused on air filtration level; it could be useful to verify how the filters' cleanliness is kept under control and eventually improve it.

As regard temperature and humidity requirements, the numerical answers are different one another. In general it is asked a cold and dry environment with air temperature between 18 – 22 °C and relative humidity between 40 % and 60 % with few answers asking for 30%. Overall the stakeholder asked for conditions proper for the scope. It could be useful to

deepen the analysis in order to see if the requirements can vary upon the different surgeries.

5.2. Lighting

Room – lighting – Doctors and Nurses

Question	Mean vote doctors	St. deviation doctors	Mean vote nurses	St. deviation nurses
There is enough artificial light in the rooms	5,6	1,8	5,9	1,5
There is enough daylight in the rooms	6,3	1,2	6,3	1,2
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	6,3	0,9	5,6	1,5
I am aware of the control capabilities of the system	4,5	2,2	4,1	1,4
I know how to adjust the system	3,9	2,4	3,7	1,9

Table 38 Room – lighting – Doctors and Nurses questionnaires results

44 clinicians were interviewed (36 nurses and 8 doctors). In this case the answers collected from nurses are similar to the ones collected from doctors.

Questionnaires highlight a good satisfaction on natural lighting availability.

As for satisfaction in the visual comfort, doctors are more satisfied than nurses.

If talking about the control system there is a medium level of satisfaction both from doctors and nurses, but with higher difference in doctors' perception (standard deviation is more than 2).

Half of the questionnaire's population would increase lighting control, with equal distribution between natural and artificial lighting.

The comments on these questionnaires have been done on a "close" question basis. The stakeholders did not leave any further comment.

Room – lighting – Patients and families

Question	Mean value	Mean value Male	Mean Value Female	Mean value over 60	Mean value under 60	Mean Value <=1 week	Mean value > 1 week
There is enough artificial light in the rooms	6,8	6,8	6,8	6,8	6,7	6,8	6,8
There is enough daylight in the rooms	6,9	6,8	7,0	7,0	6,8	6,8	7,0
Overall, how satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?	6,5	6,8	6,3	6,5	6,3	6,5	6,5

Table 39 Room – lighting – Patients and families questionnaire results

43 people interviewed, not all of them answered all the questions:

- 12 are males and 31 females
- 30 are over 60 and 13 are under 60
- 12 stayed for less than 1 week and 31 stayed for more than 1 week

The overall perception of patients and families concerning natural and artificial lighting condition seems really good. All the categories of patients and families show high medium votes (more than 6,3) with low standard deviation.

Most of them consider natural light control more important than artificial light, also asking for its improvement.

No more comments have been left by the interviewees, so the analysis has been conducted on the basis of “close” questions.