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# Project Control and Management

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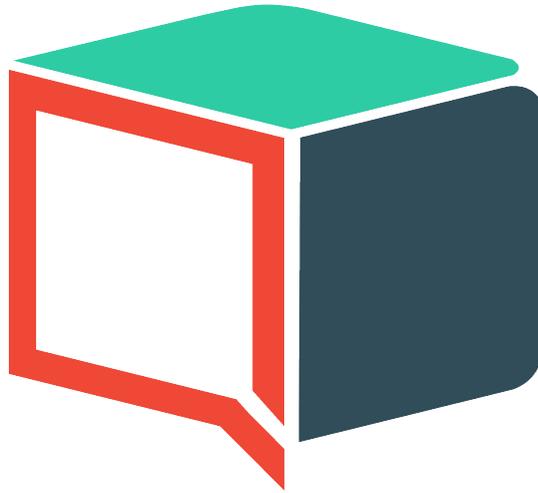
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## 1 Introduction



HOME FOR A LIVING PLANET

*Author: Dominic Zettl, Matthias Gugel, Thomas Kopp, Antonio Pomarico*

**Contributor(s):**

### 1.1 Company

QB is a German smart home automation company, which provides services for private and commercial customers. The company supports customers, who want to expand their home, condominium, factory, etc. with intelligent automated products to control their buildings, in terms of cost savings and environmental friendly use of the equipment.

The main objectives of the company are:

- Developing solutions, which are environmental friendly
- Reach the customer goals with sustainable products

## 1.2 Staff

In this chapter the staff of QB and the company's tasks shall be explained. At QB there are four employees, which are shown in Figure 1.



Figure 1: Staff

### 1.2.1 Project Manager

The project manager is responsible for the success of the current project. He defines the specification, tasks and schedules them on the project plan. Furthermore he helps the designer in implementing the graphical user interface.

### 1.2.2 Software Engineer

The software engineer develops the main part of the backend system. Together with the software architect he defines the database model and implements the business logic on the server.

### 1.2.3 Software Architect

The software architect advises in general software decisions. Together with the software engineer he defines the database model. Furthermore he is responsible for the communication with the customer.

### 1.2.4 Designer

The designer styles the user interface and advises every graphical decision. He is responsible for a modern look of the UI and appearance of the company.

## 1.3 Products

In this chapter the products of QB will be described. QB developed three system, from which only the QB-Hub and QB-Home are part of the current project.

### 1.3.1 QB-Bridge

The QB-Bridge is our developed system, which is installed on the Raspberry Pis. It acts as a bridge between different producer of home automation systems and our central system QB-Hub. Therefore it has implemented the common protocols in home automation systems. Furthermore it is developed plugin-based, so that it is possible to expand it whenever a new home automation system is released.

### 1.3.2 QB-Hub

QB-Hub is our central system, which runs on a server usually in the customers' building. It collects the data of the Raspberry Pis of the building and provides a database to save the data historically. This helps to generate reports or statistics. Furthermore it contains the business logic of our web application QB-Home.

### 1.3.3 QB-Home

QB-Home is the user interface for the control system of each registered product on the Raspberry Pi. The user interface is implemented responsive, so that it could be used on every device with different size of screen.

## 2 Aim & objectives

**Author:** *Dominic Zettl*

**Contributor(s):** *Thomas Kopp*

### 2.1 Aim

With the modularity of our system we want to support as many people as possible in living a sustainable and environmentally caring life, nevertheless which devices they want to use in automating their homes.

## 2.2 Objectives

The customers' satisfaction is our major priority. Hence we want to have an average customer satisfaction of at least 90 per cent.

We want to increase our profit in the year 2016 by 15 per cent. This ensures to reinvest a part of the profit into research and further acquisitions of the company.

To support new technologies and protocols in the house automation, we want to invest 30 per cent of our profit into innovation projects.

To offer an environment friendly system, we want to reduce the energy and water consumption of our customers by 15 per cent a year.

## 3 Planning the project

**Author:** *Dominic Zettl*

**Contributor(s):** *Antonio Pomarico, Thomas Kopp, Matthias Gugel*

### 3.1 Specification

In this chapter the specification of the developed control system will be described. The specification depends on the customers' description of the system in Appendix 9.0.1 and has further details of limitations or the technical implementation. Additionally it makes sure, that the representative does understands the customers' needs and agrees his requirements.

#### 3.1.1 Scope

The control system shall support different actors with controlling their specific part of the building. It shall provide a GUI which is used to display or modify the units in the building. Initially the system should have enough resources to supply 50 flats. The system should scale vertically.

#### 3.1.2 Control system features per flat

The control system shall power on/off

- Floor heating
- Lights
- Air condition

- The heating automatically if the state of the window changes

The control system shall allow to configure the

- Temperature of the floor heating
- Air condition

The control system shall display the

- Temperature of the floor heating
- Broken lights
- State of the air condition
- Broken air condition
- Power state of flat lights

The control system shall keep track of:

- The floor heating

The control system shall provide a questionnaire which is used to present the satisfaction of the inhabitant

### 3.1.3 Control system features for the building manager

The control system shall report (monthly) the

- Electricity and water consumption per flat
- Heating consumption per flat and for the whole building

- Status of the smoke detectors
- Status of the lights system
- Status of the heating system
- Status of the air condition system
- Temperatures in the general rooms
- Resident's feedback

#### 3.1.4 Control system features for the local authorities

The control system shall report (monthly) the

- Rating of electricity and water consumption in colours (green/yellow/red)
- Status of flats (inhabited or not)

#### 3.1.5 Control system features for the residents committee

The control system shall report (monthly) the

- Resident's satisfaction
- Status of the smoke detectors
- Status of the lights system
- Status of the heating system
- Status of the air condition system
- Status of the access door

- Average electricity and water consumption
- Status in flat (inhabited or not)
- Status of how their residents feedback got handled

### 3.1.6 Control system features for underground car park

The control system shall provide an access control with chip card and PIN code

The control system shall display the number of free parking spots.

### 3.1.7 Control system features for caretaker

The control system shall power on/off

- The lights in the outside play area by motion detectors
- the general air condition system

The control shall allow the configuration of:

- the temperature in the general rooms (floors, entrance hall, ...)
- fire alarm & smoke detectors (reset only)

### 3.1.8 Control system features for the outer area

The control system shall run an automated irrigation system for the gardening area.

The control system shall keep track of the electrical consumption of the outside lights.

### 3.1.9 Control system features for the building

The control system shall be able to manage and to archive the video observation material from the entrances.

### 3.1.10 Implementation

The sensors and subsystems will be bought of our partner companies. For the communication part between these subsystems and our central system QB-Hub, we develop an adaptable control system QB-Bridge. On QB-Hub a server application in ASP.NET will be developed. To ensure a persistent data integrity, a SQL database will be supplied. To enable a easy database transfer we use the Microsoft Entity Framework. For the residents and parties allowed to see reports a frontend application (QB-Home) will be developed. QB-Home will also have an export function to print the reports as PDF.

## 3.2 Basic concept

Based on the requirements and the specification a basic concept was defined and is shown in Figure 2.

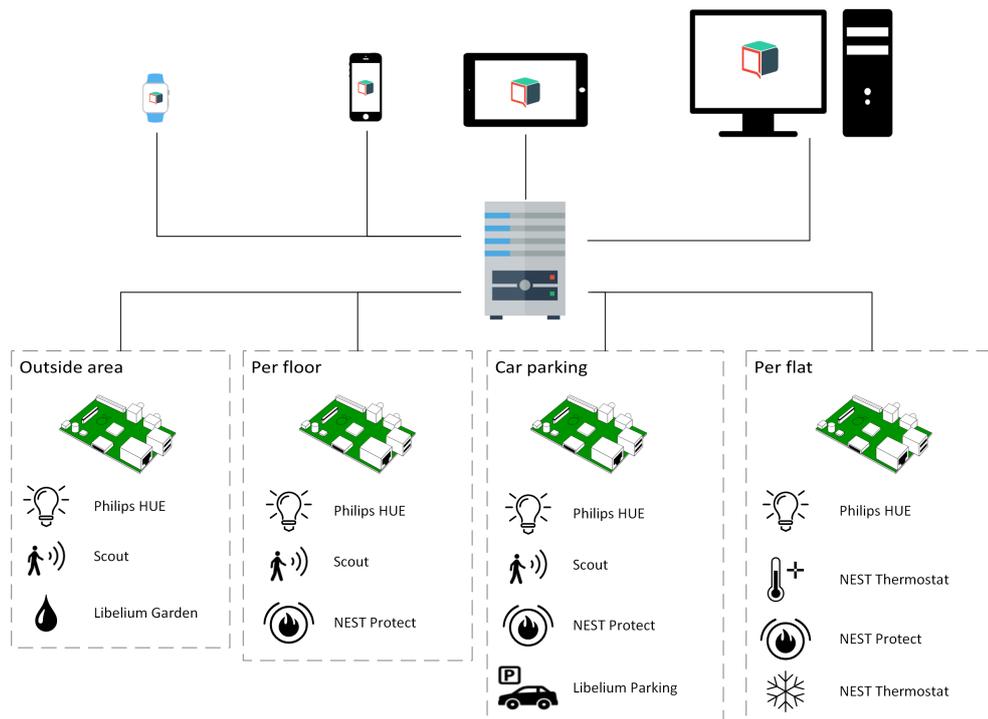


Figure 2: Basic concept

The concept is based on the products of QB, the needed hardware sensors and the subsystem of each sensor. As described in the introduction, the products of QB are three general systems which communicate with each other. In the rectangles, the specific area in the building is noted. The sensors for home automation are displayed as an icon and assigned to an area. On the right of the sensor icon, the related subsystem is labelled. A subsystem sends the collected sensor data to the QB-Bridge, which communicates with the QB-Hub. These subsystems are already manufactured and get sold by the company of the sensor. The QB-Hub collects the data of each area in the building and provides a web UI for the residents of the building.

### 3.3 Project plan

A project plan is used to schedule the duration, tasks, milestones and resources of a project in one document. Therefore the tasks have to be specified out of the specification in chapter 3.1. After the tasks are defined, the duration of each task has to be estimated. Then the tasks can be scheduled on the project plan and linked with a resource. The number of resources depends on the size of the team, which is working on the project. The accessibility of each employee can vary, depending on other works which have to be done by the team member or the specified working hours per week of the employee.

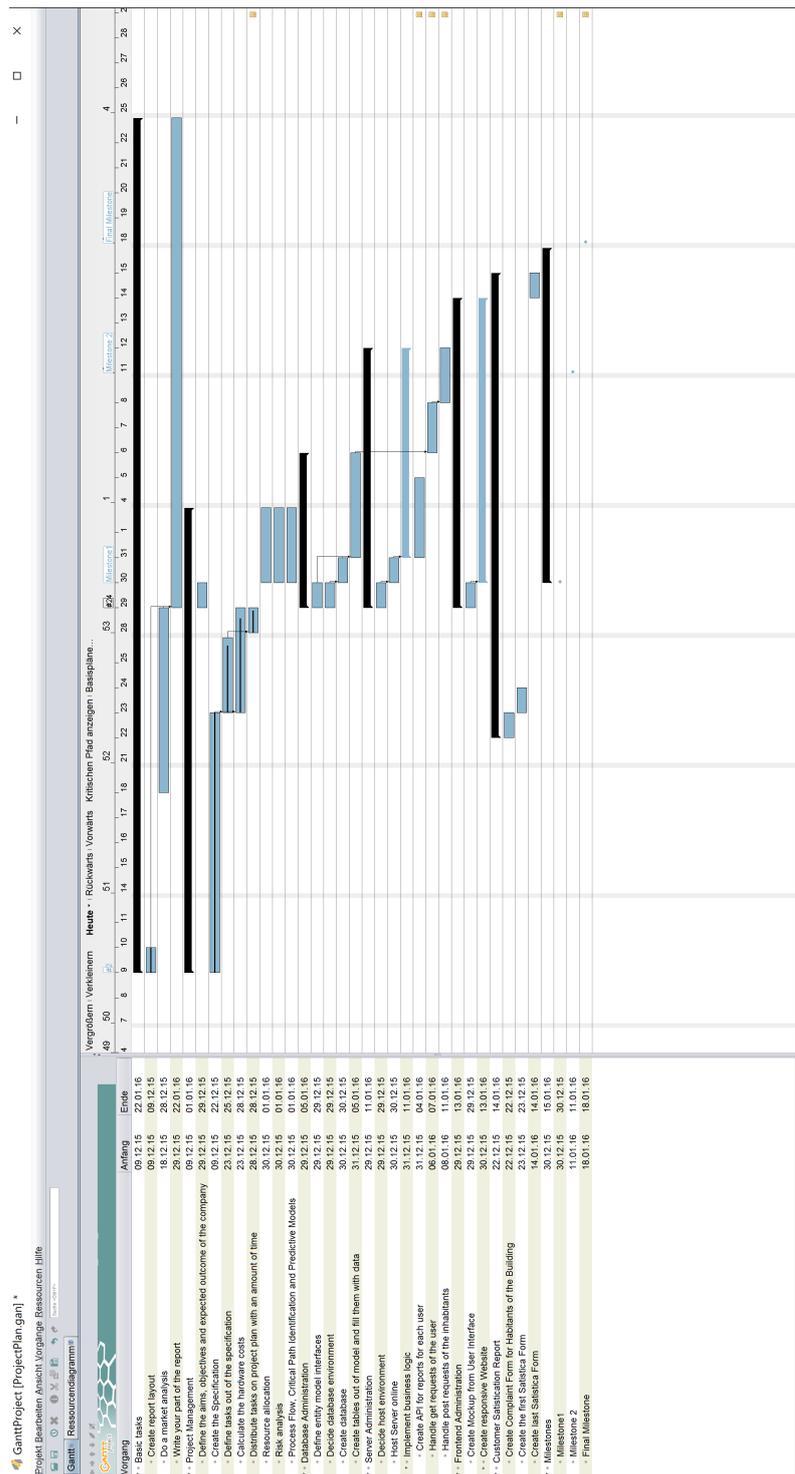


Figure 3: Initial project plan

Figure 3 shows the initial project plan. In the project plan, three milestones were specified. These milestones define three fix stages of the project, which tell at which time a specific part of the project has to be done. In addition it can be seen, that the work is planned irregular. For example in December 18-23 there were a lot of worked planned, because all had vacation and there were no other master courses. At the end of the project there is also much work planned, because the focus is on finishing the project and not on other modules.

As mentioned there were added some tasks during the time of the project. For instance, the big report task were split into smaller tasks, which help to identify which work has to be done. The final project plan can be seen in Figure 4.



Figure 4: Final project plan

### 3.3.1 Resource plan

In this project the work hours of each employee was determined with about 100 work hours such as given in the module description. These work hours can be seen in Figure 5 and were scheduled to the tasks over the whole period of time.

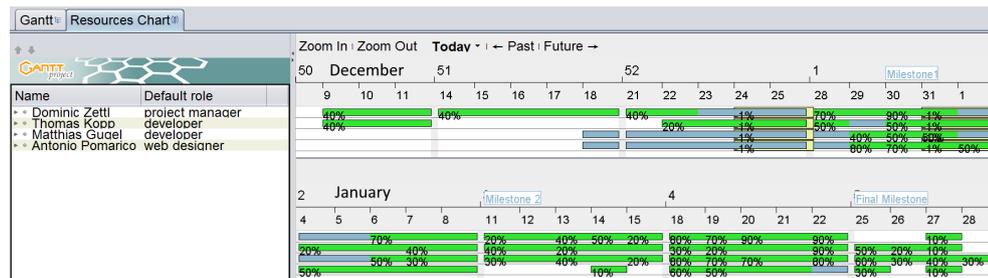


Figure 5: Resources chart

The tasks of each employee mostly depends on the given role in the company. The designer for instance has mainly worked on the layout of the control system and were responsible for the layout of the documents. After scheduling the work hours of each resource to the tasks, the cost calculation can be done. Therefore Microsoft Project 2013 was used, because it can create specific reports for the informations in the project plan. In Figure 6 the total hours per resource can be seen.

## RESOURCE OVERVIEW

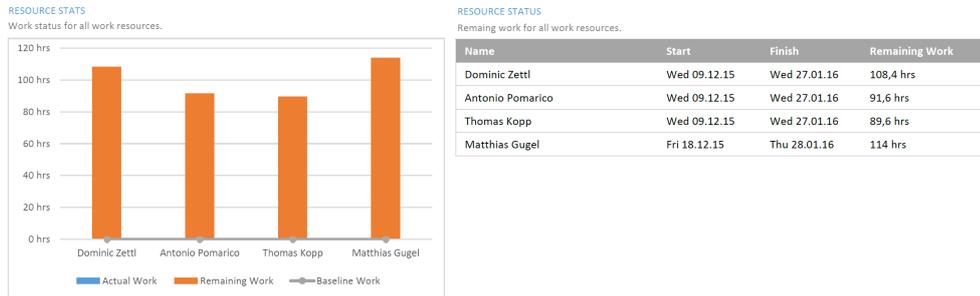


Figure 6: Estimated hours per resource

Out of the estimated hours per employee, the costs for the resources and tasks can be calculated. Figure 7 shows the total costs and the scheduled costs for each task. An employee receives 100 € per hour, this makes a total cost amount of 40,360 €.

## COST OVERVIEW



Figure 7: Estimated cost calculation for the resources

### 3.4 Tracking work with Kanban

Next to the typical project plan of the previous chapter, a Kanban was used to track the progress of each task. Kanban is a typical process model to manage agile software development. It helps to display the current state of a task and to identify problems or a deadline shift early. To visualize and modify the Kanban board, the free website tool KanbanFlow was used and filled with the tasks of the project plan. On Figure 8 the initial Kanban board can be seen.

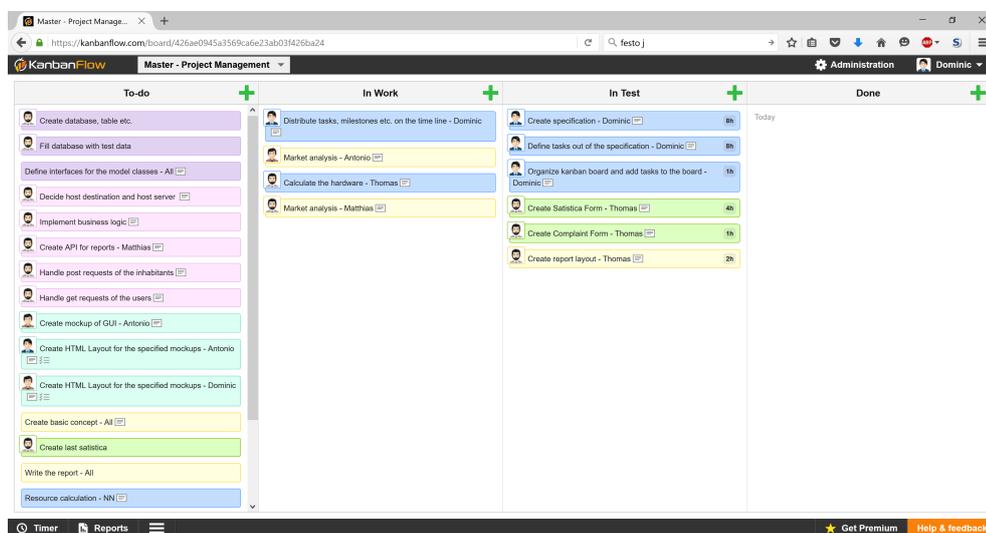


Figure 8: Initial Kanban Flow Diagram

A Kanban board consists of a board with columns and cards. The cards represent tasks which have an estimated time to execute the task. Furthermore they are distributed to one or more contributors. The columns represent the development process of a typical task. Therefore 4 columns were added to the Kanban board.

In Figure 9 the Kanban board of the 23. January in 2016 can be seen.

Compared to the initial Kanban board there were added some tasks. The task "Write the report" of the first Kanban board were split in several tasks, because it was too big to draw a conclusion out of the tasks status. With the new report tasks the work process of each employee can be seen better and is more specific.

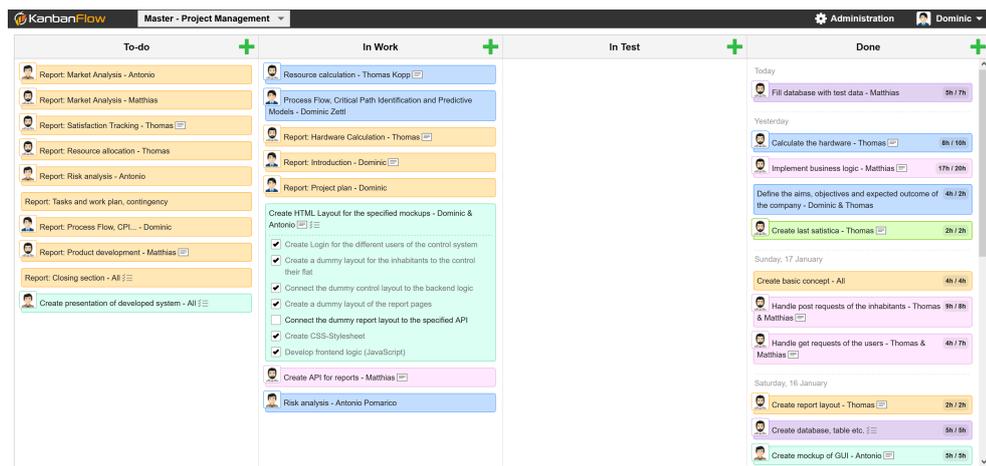


Figure 9: Kanban Flow Diagram 01/23/2016

On the figure, the work flow of the elapsed time can be seen very well. The main tasks were finished and the remaining tasks are mainly a part of writing the report or create the presentation of the system. When estimating the current state of the system the due date at 25. January 2016 is realistic.

## 4 Market analysis

**Author:** *Antonio Pomarico*

**Contributor(s):** *Matthias Gugel, Thomas Kopp*

Before starting to develop a product it is important to know if there are companies offering the same or similar product on the market. A market analysis includes also the comparison and the right choose of the products and take care of the requirements of the customer. There are many methods to make a market analysis. The one used for this project is an indirect method. That means that we collect all useful information.

In this environment, there are countless of companies offering smart home automation companies. For example:

- Companies, who offers smart home products in form of hardware and a matching software, mostly as an mobile application or web application. That cause the problem, that a customer, if he has more than one smart home product, he has to operate different software application for each product.
- Companies, who offers services, which is able to register every smart home device and make them working in only one software application.

Our company offers, therefore, the software that runs on the Raspberry PI and the support of them, the server functionality and the set up of the smart home devices of different companies.

In order to realize the product for our customer in terms of the requirements, various sensors and other measurement devices are needed.

Table 1 has been created after a market analysis regarding the different devices. The decision was made answering the regarding following questions after made an internet investigation:

- Is the product on a high level of the maturity?
- Is the support for the device and the bundled software sufficient and satisfying?
- Has the product reached an adequate online community?
- Offers the manufacturer an API to bind on our software?
- How are the reviews and the opinions about the candidate devices?
- Is one manufacturer able to cover more than one control system?

There are many manufacturer, who covers just one control system. For example Philips Hue for light system, netatmo for a pleasant ambience. For the measurement of electricity there is the manufacturer smappee and for measurement of water there is the manufacturer driblet. Devices of other companies are able to cover more than one control system. For example libellium for the parking control system and the garden irrigation. The company scout manufactures security devices, like alarm devices, surveillance camera and motion detectors. NEST offers products for the heating system and the smoke detection. All these companies meet the above criteria.

System	Light	Heating	Smoke detector	Alarm	Electricity	Water	Ambience	Garden	Parking	Surveillance	Motion sensor
Phillips Hue	+	-	-	-	-	-	-	-	-	-	-
NEST	-	+	+	-	-	-	-	-	-	+	-
netatmo	-	+	-	-	-	-	+	-	-	+	-
libelium	-	-	-	-	-	-	-	+	+	-	-
tado	-	+	-	-	-	-	-	-	-	-	-
scout	-	-	-	+	-	-	-	-	-	+	+
smappee	-	-	-	-	+	-	-	-	-	-	-
driblet	-	-	-	-	-	+	-	-	-	-	-

Table 1: Systems

#### 4.1 Hardware calculation

The project requires sensors and other measurement devices as well as supporting devices for the sensors. This equipment is enlisted and calculated in the table below. For devices for which it has not been possible to evaluate a price the given price has been estimated.

Device	Price per unit	Living room	Kitchen	Bathroom	Bedroom 1	Bedroom 2	Flat	Units per single flat	Units per double flat	Building	Total units	Total in [€]
Phillips Hue Bridge	57,30 €						1	1	1	12	62	3.552,60 €
Phillips Hue White Lamp	19,95 €	3	2	1	2	2	8	10	244	694	13.845,30 €	
NEST Learning Thermostat	229,73 €	1	1	1	1	1	4	5		225	51.688,35 €	
NEST Protect	91,34 €	1			1	1	2	3	12	137	12.513,15 €	
NEST Cam security camera	458,53 €						0	0	1	1	458,53 €	
NETATMO weather station	169,00 €	1					1	1		50	8.450,00 €	
Additional module	69,00 €				1	1	1	2		75	5.175,00 €	
Libelium Open Garden	199,00 €						0	0	1	1	199,00 €	
Libelium Meshlium (LoRa-3G-AP-868)	840,00 €						0	0	6	6	5.040,00 €	
Libelium Plug & Sense! (SP LoRaWAN -868)	360,00 €						0	0	100	100	36.000,00 €	
Scout Motion Sensor	45,21 €						0	0	89	89	4.023,43 €	
Scout Hub	119,01 €						1	1	1	51	6.069,75 €	
Scout Access Sensor	26,76 €						1	1	3	53	1.418,03 €	
Scout Door Panel	63,66 €						0	0	1	1	63,66 €	
Smappee Monitor	199,00 €						1	1	1	51	10.149,00 €	
Driblet (estimated)	200,00 €						1	1	1	51	10.200,00 €	
Raspberry Pi 2 B	32,87 €						1	1	15	65	2.136,55 €	
Laundry rooms											100.000,00 €	
Access control parking (estimated)											15.000,00 €	
Company cost(employees)											200.000,00 €	
Craftsmen (120 days)											60.000,00 €	
Project total											<u>549.453,14 €</u>	

Table 2: Hardware pricing table

## 5 Project management

### 5.1 Resource allocation

**Author:** *Thomas Kopp*

**Contributor(s):**

For a project manager it is of high importance to be aware of all usable and potentially not usable resources throughout the complete project duration. Therefore it is important for a project manager to know at which specific point he/she needs a specific kind of person to solve a specific problem. This is based on the fact that not every kind of person is made for every kind of task. A nice example here might be that a software engineer might help a surgeon with providing software for a intensive care patient monitor but nobody (at least not in a professional business) would like the software engineer to do the surgeon's job. But what is this small episode telling at all? Basically two things. Know about the persons and resources you have at your service and as well at which point in time do you have them. The last point gets important if you have a person that solves problem type x for you but in this project this person won't be available when it is required to have person that can solve a problem of type x. All this leads to the importance of resource allocation. At the very beginning the planner (maybe project manager) has to break down all jobs into tasks and enlist all the required abilities within three fields (Enabler, Preferences, Attainment). All this goes congruent with Dr. Mousavi's lecture <sup>1</sup>. Every ability needs to get a level at which the ability should be

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<sup>1</sup>EE5534 Project Control & Management - Lecture 3 (updated) - Nov. 2015

present (scale from 0.0 to 1.0). This now gets merged over all tasks that are part of a job (an example is provided on page 32 at table 3. The merge is done by choosing the maximum if an ability is required in more than one task. After that the each group gets n weights (1 per ability and the sum has to equal 1) and an availability needs to be set for each availability (normally by the availability of the persons who have this or that ability/preference/attainment. Subsequently the values for  $A'_{ijk}$  can be calculated using the formula from the source above. Unluckily the complete algorithm could not been applied since there were problems regarding the parameter understanding. But on the other side the weighting for each task could be accomplished and the intention behind the algorithm is now clear.

Create basic concept	C <sub>111</sub>	Writing skills	C <sub>11</sub>	0.5	W <sub>11</sub>	0.1	A <sub>111</sub>	0.5	A <sub>111</sub>	1.00	A <sup>***</sup> <sub>111</sub>	1.00	
	C <sub>121</sub>	Language skills	C <sub>12</sub>	0.7	W <sub>12</sub>	0.1	A <sub>112</sub>	0.6	A <sub>112</sub>	1.00	A <sup>***</sup> <sub>112</sub>	1.00	
	C <sub>131</sub>	Creativity	C <sub>13</sub>	0.8	W <sub>13</sub>	0.2	A <sub>113</sub>	0.5	A <sub>113</sub>	1.00	A <sup>***</sup> <sub>113</sub>	1.00	
	C <sub>211</sub>	Intuition	C <sub>14</sub>	0.7	W <sub>14</sub>	0.2	A <sub>114</sub>	0.3	A <sub>114</sub>	1.00	A <sup>***</sup> <sub>114</sub>	1.00	
		Predicting possible risks	C <sub>15</sub>	0.5	W <sub>15</sub>	0.1	A <sub>115</sub>	0.5	A <sub>115</sub>	1.00	A <sup>***</sup> <sub>115</sub>	1.00	
		Knowledge of layouting	C <sub>16</sub>	0.75	W <sub>16</sub>	0.1	A <sub>116</sub>	0.7	A <sub>116</sub>	1.00	A <sup>***</sup> <sub>116</sub>	1.00	
		Dense up information	C <sub>17</sub>	0.5	W <sub>17</sub>	0.1	A <sub>117</sub>	0.75	A <sub>117</sub>	1.00	A <sup>***</sup> <sub>117</sub>	0.67	
	Basic tasks	C <sub>311</sub>	Analysing and Interpreting	C <sub>18</sub>	0.85	W <sub>18</sub>	0.1	A <sub>118</sub>	0.8	A <sub>118</sub>	1.00	A <sup>***</sup> <sub>118</sub>	0.63
		C <sub>312</sub>	Innovative projects	X <sub>312</sub>	.85					A <sub>118</sub>	0.63	A <sup>***</sup> <sub>118</sub>	0.63
	Do a market analysis	C <sub>112</sub>	Predicting possible risks	C <sub>21</sub>	0.7	W <sub>21</sub>	0.2	A <sub>121</sub>	0.9	A <sub>121</sub>	0.44	A <sup>***</sup> <sub>121</sub>	0.44
C <sub>122</sub>		Language skills	C <sub>22</sub>	0.4	W <sub>22</sub>	0.3	A <sub>122</sub>	0.7	A <sub>122</sub>	0.71	A <sup>***</sup> <sub>122</sub>	0.71	
C <sub>212</sub>		Be informed about the latest stuff	C <sub>23</sub>	0.5	W <sub>23</sub>	0.25	A <sub>123</sub>	0.7	A <sub>123</sub>	0.70	A <sup>***</sup> <sub>123</sub>	0.71	
		Analysing and Interpreting	C <sub>24</sub>	0.85	W <sub>24</sub>	0.25	A <sub>124</sub>	0.6	A <sub>124</sub>	0.60	A <sup>***</sup> <sub>124</sub>	1.00	
C <sub>313</sub>		Market research experience	X <sub>313</sub>	0.8					A <sub>124</sub>	0.60	A <sup>***</sup> <sub>124</sub>	1.00	
Create report layout	C <sub>113</sub>	Design skills	C <sub>31</sub>	0.85	W <sub>31</sub>	0.4	A <sub>131</sub>	0.7	A <sub>131</sub>	0.70	A <sup>***</sup> <sub>131</sub>	1.00	
	C <sub>123</sub>	Knowledge of layouting	C <sub>32</sub>	0.8	W <sub>32</sub>	0.2	A <sub>132</sub>	0.8	A <sub>132</sub>	0.80	A <sup>***</sup> <sub>132</sub>	1.00	
	C <sub>213</sub>	Likes to work with layouting software	C <sub>33</sub>	0.75	W <sub>33</sub>	0.1	A <sub>133</sub>	0.4	A <sub>133</sub>	0.40	A <sup>***</sup> <sub>133</sub>	1.00	
		Experience with bussiness layouts	C <sub>34</sub>	0.45	W <sub>34</sub>	0.1	A <sub>134</sub>	0.5	A <sub>134</sub>	0.90	A <sup>***</sup> <sub>134</sub>	0.90	
	C <sub>313</sub>	Successful presentations	C <sub>35</sub>	0.5	W <sub>35</sub>	0.2	A <sub>135</sub>	0.5	A <sub>135</sub>	1.00	A <sup>***</sup> <sub>135</sub>	1.00	
Create presentation of the system	C <sub>313</sub>	Experience with bussiness layouts	X <sub>311</sub>	.45					A <sub>135</sub>	1.00	A <sup>***</sup> <sub>135</sub>	1.00	
	C <sub>113</sub>	Dense up information	X <sub>111</sub>	.5					A <sub>135</sub>	1.00	A <sup>***</sup> <sub>135</sub>	1.00	
	C <sub>123</sub>	Design layout skills	X <sub>121</sub>	.5					A <sub>135</sub>	1.00	A <sup>***</sup> <sub>135</sub>	1.00	
	C <sub>133</sub>	Creativity	X <sub>131</sub>	.6					A <sub>135</sub>	1.00	A <sup>***</sup> <sub>135</sub>	1.00	
	C <sub>213</sub>	Likes to present	X <sub>211</sub>	.6					A <sub>135</sub>	1.00	A <sup>***</sup> <sub>135</sub>	1.00	
C <sub>313</sub>	Successful presentations	X <sub>311</sub>	.5					A <sub>135</sub>	1.00	A <sup>***</sup> <sub>135</sub>	1.00		

Table 3: Resource allocation table

## 5.2 Risk Analysis

**Author:** *Antonio Pomarico*

**Contributor(s):**

Every decision made in a project is connected with a risk factor. To anticipate and neutralize any problem, before starting with the planning phase of the project, it is important to make a risk analysis. Before making a risk analysis you have to identify possible threats, which could be happen in the project.

### 5.2.1 Identify possible risks

For the project the customer gave us about five weeks, to realize the product. Possible types of risks, which could arise are the following: (The values are the estimated probability of occurrence of the risk)

- Personal
  - Illness (0.5)
  - Injury (0.3)
  - Temporal overload (0.7)
- Financial
  - Going over the budget (0.2)

- Project
  - Too long time for concluding tasks (0.5)
  - Deadline not comply (0.6)
  - Goal not achieved (0.4)
  - Result does not meet the required quality (0.5)

### 5.2.2 Estimate the risk

Before searching for a response on each type of risk it is more important to classify the risks and estimate what the risk can do to the project and how hard it could impact the project.

Quantitative analysis is a method to measure a risk:

$$Risk = Probability\ of\ Occurance \cdot Cost \quad (1)$$

It depends in which constellation the process flow is. There are processes they are processed in series, because the subsequent process has some dependencies and there are processes they are processed in parallel, they could be executed independently.

$$Risk = Probability\ of\ Occurrence \cdot Cost \quad (2)$$

It depends in which constellation the process flow is. There are processes they are processed in series, because the subsequent process has some dependencies and there are processes they are processed in parallel, they could be executed independently.

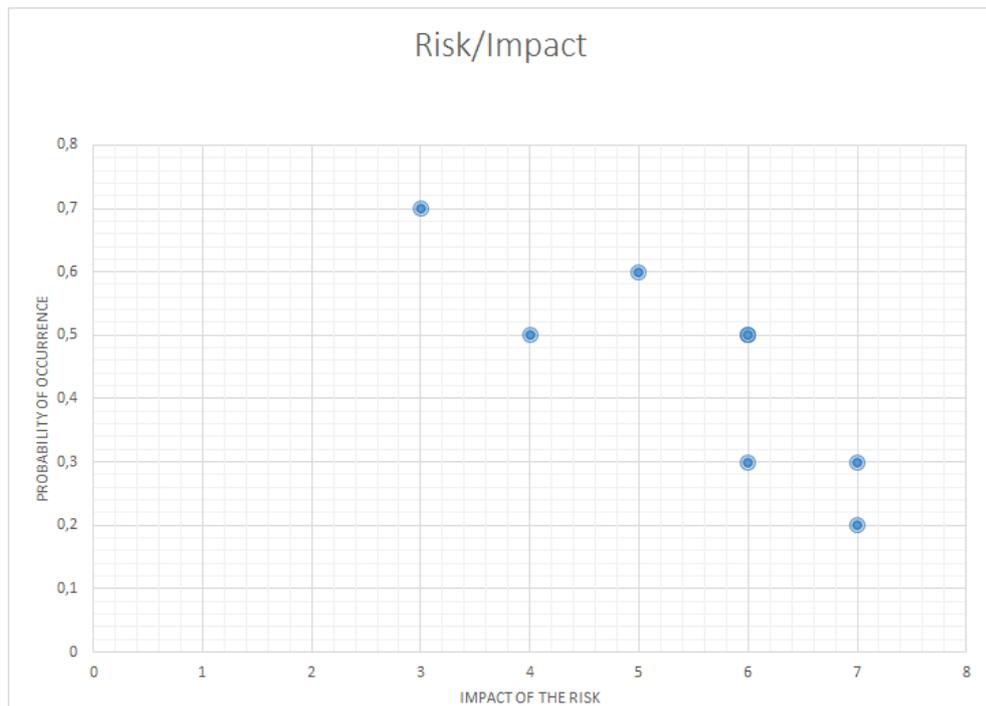


Figure 10: Risk/Impact diagram

In figure 10 is displayed the impact of the risk scaled in scala from 1 to 10. 1 means, the impact isn't really hard for the project and 10 means the impact is immense for the project. The y-axis is the probability of occurrence of a risk.

### 5.2.3 Response to the risk

After identified and estimate the risks and their possible impact on the project, it is essential to elaborate a so-called "Plan B" or at least have an appropriate reaction to the effect of the risk.

To have a an appropriate reaction, if a team member is ill, injured or has to

much tasks assigned, then the tasks should distributed uniformly on the other member of the team. That means that at the beginning of the project, the difficulty of the tasks should be estimated and distributed dependent on the difficulty of the tasks. If the overloading is too immense, also for the team member, than helps a conversation with the customer.

If the available budget is not enough, then it should be discussed with the customer or the company should pay for the additional costs. To avoid this big problem, it should be made a market analysis before starting in planning the project.

### 5.3 Tasks and Critical path

**Author:** *Dominic Zettl*

**Contributor(s):**

As described in Subsection 3.3, the tasks were added to the project plan, based on the specification. The resulted project plan supports different views for further analysis. To determine the resources and time for each task, the network diagram is often used. In Figure 11 the network diagram for the current project is shown.

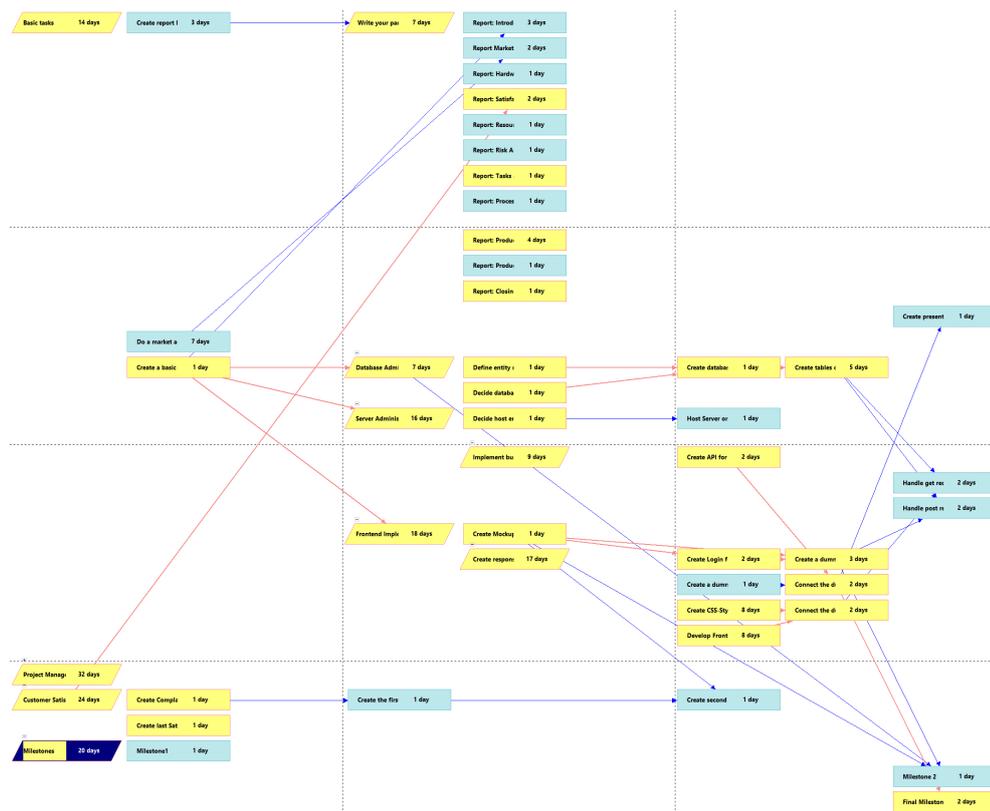


Figure 11: Network diagram

The critical tasks have a yellow background. It can be seen that the report tasks are also marked critical. Since most of them are scheduled at the end of the period, a delay of a task will delay the delivery of the project. Network diagram is a flow chart of all tasks in a project. The chart is used to visualize the relationships between the tasks, as seen in the figure. Furthermore it provides a logical flow of the events and helps to identify the critical path. The critical path is the longest duration path in the network diagram and contains several critical tasks. Whenever a critical task delays, the due date of the project delays, too. To avoid a delay a buffer for the critical tasks or additional resources for the task should be

planned.

The critical tasks have a yellow background and the normal tasks a turquoise background. On the figure, it can be seen that the report tasks are also marked as critical. Since most of them are scheduled at the end of the period, a delay of a task will delay the delivery of the project. This causes, that they are critical, too. As there are multiple critical paths, the two most significant critical paths are displayed in Figure 12.

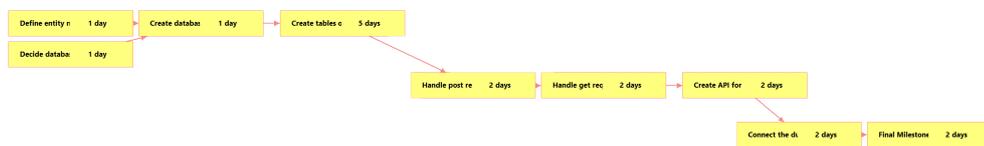


Figure 12: Critical paths

The two critical paths have a length of 17 days and are tasks of the implementation process. Since there are the most related tasks, it was expected that there is one of the most significant critical paths.

## 6 Customer reports and analysis

**Author:** *Thomas Kopp*

**Contributor(s):**

According to Dr. Mousavi<sup>2</sup> trying to reach and keep a high level of customer satisfaction is very important for the current project as well as for the future. In order to achieve this it is crucial to maintain a good way of customer communication as well as trying to harmonise the current project development with the requirements, expectations and perception of the customer. In this point agile methods like Kanban or Scrum can help to achieve this. But it is also important to note that agile methods cannot be applied to all kind of projects.

A point in harmonising as well as in communicating is to embed the voice of the customer into the project. Therefore it is very helpful to evaluate the customer's satisfaction at specific project milestones. The first milestone is after the conceptualisation when the customer's requirement are transformed into the specification. This shall be covered by 6.1. After designing the product and having a first prototype (mainly the user interface because its the part of the system the user sees first) this prototype should be evaluated as well. This shall be achieved by 6.2. The two mentioned steps are repeated when using agile methods but only for one small part of the whole project. When all requirements are transformed & all development is done, the final project steps need to be done (like writing a user manual) including a final satisfaction survey (see 6.3).

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<sup>2</sup>EE5534 Project Control & Management - Lecture 7 - Nov. 2015

## 6.1 Understanding of requirements

The first survey has been created with the intention of getting maximum input regarding the user requirements. Changing the direction during the first steps of the project is not very cost intensive but helps to avoid further costs because of major disagreement regarding the understanding of the requirements. The survey itself you can find in the appendix beginning on page 83. Additionally there is more input by mail attached after the questionnaire result. In general the results are quite okay but there are points which are quite clear which need or may need an improvement. There survey has been taken only once by the customer.

Form title	Form average Satisfaction Value by CORE	Number of sections	Number of questions	Answered by	Answered on	CORE verbal range	CORE colour
Importance of single contract/specification aspects V6	59	8	16	pcm2015TeamBramk	2016-01-16	Fair	

Section title	Form average Satisfaction Value by CORE	Number of questions	CORE verbal range	CORE colour
General Questions	73	3	Good	
Reporting	None	3	-	
Surveillance cameras	None	3	-	
Alert handling	None	2	-	
Laundry room	None	1	-	
Further question on the system	None	2	-	
Networking	None	1	-	
Summary	44	1	Poor	

Section	Question title	Value	Type	Mandatory	CORE	CORE verbal range	CORE colour
General Questions	How important for you is to stay below the financial frame given?	76	Exclusive choice	Yes	Yes	Excellent	
<ul style="list-style-type: none"> <li>● Important (with possible negotiation if needed)</li> </ul>							
General Questions	How much coverage do you expected regarding your requirements?	100	Exclusive choice	Yes	Yes	Outstanding	
<ul style="list-style-type: none"> <li>● Slight differences are okay (~75%)</li> </ul>							
General Questions	How important for you is being in time (Deadline 26th of January)?	44	Exclusive choice	Yes	Yes	Poor	
<ul style="list-style-type: none"> <li>● Greater delay might be acceptable if the reasons can be explained. Only allowed if problems are communicated early. Will result in a fine.</li> </ul>							

Reporting	In which format the reports shall be delivered?	-	Multiple choice	Yes	No	-
-----------	---	---	-----------------	-----	----	---

- By e-Mail with report attached at pdf
- PDF for download

Reporting	In your requirements you state that the system shall report how the residents' feedback has been handled? What do you mean exactly by that? What actions has been resulting from stating the feedback? How much the resident who handed in the feedback is satisfied with the outcome? Please provide a detailed description what you expect for this point regarding the content of the report.	-	Textual	Yes	No	-
-----------	--	---	---------	-----	----	---

- The residents shall be able to see if the building manager or someone else replied to their feedback. If there is a reply it should be stated in the report. \nTherefore it makes sense that the responsible person who handles the residents feedbacks has to reply to each feedback. At the end it is a log of the feedback communication. A nice but not necessary feature would be if the residents could mark the feedback as resolved or unresolved.

Reporting	For the local authority report it is necessary to provide a coloured rating for the consumption of electricity and water. But there is no mention of any threshold for a single or double bed room flat.	-	Exclusive choice	Yes	No	-
-----------	--	---	------------------	-----	----	---

- No, just do like you want.

Surveillance cameras	What time frame shall be covered by the surveillance?	-	Exclusive choice	Yes	No	-	
----------------------	---	---	------------------	-----	----	---	--

- 1 month

Surveillance cameras	Which medium shall be used for storing?	-	Exclusive choice	Yes	No	-	
----------------------	---	---	------------------	-----	----	---	--

- Hard disk

Surveillance cameras	Must the captured material be archived afterwards?	-	Exclusive choice	Yes	No	-	
----------------------	--	---	------------------	-----	----	---	--

- No

Alert handling	In which time frame a medium alert has to be handled (concrete solution might need little longer) ?	-	Exclusive choice	Yes	No	-
----------------	---	---	------------------	-----	----	---

- within 2-3 businessdays

Alert handling	In which time frame a low level alert has to be handled (concrete solution might need little longer) ?	-	Exclusive choice	Yes	No	-
----------------	--	---	------------------	-----	----	---

- within 3-5 business days

Laundry room

Is it necessary to have (recurring) reports about the laundry room (electricity/water consumption, ..) like the other reports?

-

Exclusive choice

Yes

No

-

- Yes, monthly for the building manager

Further question on the system	Where shall the control system be hosted?	-	Exclusive choice	Yes	No	-	
--------------------------------	---	---	------------------	-----	----	---	--

- On site

Further question on the system	How many days may a the system be not online?	-	Exclusive choice	Yes	No	-	
--------------------------------	---	---	------------------	-----	----	---	--

- up to two days

Networking	Currently IPv6 cannot be utilized efficiently due to missing hardware (especially when going for sensors). Also most hardware capable of IPv6 is actually a combination of IPv4 and IPv6 - so called "dual stack" (IPv4 for private areas). This means that each flat will run IPv4 and the system IPv6. Recalibration to IPv6 only afterwards (if hardware is available) will result in massive costs (hardware replacement, installation, software reconfiguration). Currently we cannot recommend using IPv6. Do	-	Exclusive choice	Yes	No	-	
------------	---	---	------------------	-----	----	---	--

- No, we are fine with IPv4

Summary

How well are the requirements covered by the provided specification?

44

Exclusive choice

Yes

Yes

Poor



- We are happy with your draft but have small recommendations.

Hello Thomas Kopp,

I just filled the statistica form regarding the specifications and as mentioned in this form I have some comments.

The electricity and water consumption of the whole building should also be displayed in the report for the building manager

The laundry rooms are consequently included in this overview so it doesn't have to be displayed separately

That's all I got. Thank you for giving us the opportunity of taking part in the development process to avoid misunderstandings and mistakes.

Best regards

Mathis Bramkamp

GFES - German Facility Engineering Solutions

"Engineering made in Germany"

Thomas Kopp <thomas.kopp@stz-softwaretechnik.de> schrieb am Do., 7. Jan. 2016 um 20:30 Uhr:

Dear Ladies and Gentlemen,

attached to this e-mail you receive our specification and the UI mock-ups for your project.

As well we have a form for you to fill at www.statistica.com. The credentials below will guide you to the form.

Please respond as soon as possible.

user: pcm2015TeamBramkamp

password: Pcm20151!

In case of questions please contact using this mail adress thomas.kopp@stz.softwartechnik or dominic.zettl@stz-softwaretechnik.de

With kind regards

Team of qbHUB

## 6.2 Discussing the User Interface

The second survey has been performed after reaching the UI mockup milestone. After having the mockups finished a request has been sent to the customer including the mockups as PDF (same mockups as on page 73). The reply is coming next - the blueprint (incl. rating weight) can be found in the appendix starting on page 92. Generally the feedback is very good and better than expected. There is no other kind of reply than the survey result. There survey has been taken only once by the customer.

Form title	Form average Satisfaction Value by CORE	Number of sections	Number of questions	Answered by	Answered on	CORE verbal range	CORE colour
Questionnaire regarding Ui mockups for building Project	76	2	4	pcm2015TeamBramk	2016-01-16	Excellent	

Section title	Form average Satisfaction Value by CORE	Number of questions	CORE verbal range	CORE colour
The pro side of the UI mockups	76	2	Excellent	
The downside of the UI mockups	None	2	-	

Section	Question title	Value	Type	Mandatory	CORE	CORE verbal range	CORE colour
The pro side of the UI mockups	Do you like what you see so far ?	76	Exclusive choice	Yes	Yes	Excellent	
<ul style="list-style-type: none"> <li>● We are really pleased by what you have done!</li> </ul>							
The pro side of the UI mockups	Are there points/details you really like about our mockups? Describe as precise as possible please.	-	Textual	No	No	-	

The downside of the UI mockups	Are there points/details in the mockups you do not like ?	-	Exclusive choice	Yes	No	-	
--------------------------------	---	---	------------------	-----	----	---	--

- No

The downside of the UI mockups	If there are points you do not like describe for us what it is. Please split up the text regarding the roles (resident, residents committee, building manager, caretaker)	-	Textual	No	No	-	
--------------------------------	---	---	---------	----	----	---	--

### 6.3 Final project evaluation

The third and currently last survey has been performed parallel to the launch of the website. The intention of the survey is to gather the customers satisfaction regarding the quality of the created product as well as the customers impressions on the steps taken within the project and the communication with the customer itself. This survey shall also help to get a self-understanding how well the project and the caring for the customer works. After all the survey result shows that the solution might have been worked out more properly but with regards to the given time and the fact that the presented state is 'only' a prototype put the facts into perspective. The customer caring worked out as expected and the results for this section are very promising. The survey blueprint is in the appendix starting on page 94.

Form title	Form average Satisfaction Value by CORE	Number of sections	Number of questions	Answered by	Answered on	CORE verbal range	CORE colour
Rating for current product development V3	77	5	14	pcm2015TeamBramk	2016-01-27	Excellent	

Section title	Form average Satisfaction Value by CORE	Number of questions	CORE verbal range	CORE colour
Coverage of functional requirements	70	3	Good	
Reports	91	2	Outstanding	
Complaints	91	2	Outstanding	
UI	51	3	Fair	
General project process questions	81	4	Excellent	

Section	Question title	Value	Type	Mandatory	CORE	CORE verbal range	CORE colour
Coverage of functional requirements	How well are the functional requirements covered up to now?	70	Exclusive choice	Yes	Yes	Good	
<ul style="list-style-type: none"> <li>● Around 75%</li> </ul>							
Coverage of functional requirements	Which functional requirements do you think need implementation refinements?	-	Textual	No	No	-	
<ul style="list-style-type: none"> <li>● The use case, that the heating powers down when the windows are opened is not implemented or at least not visible. Are the alerts also created automatically or is the only way to have an alert the manual creation?</li> </ul>							
Coverage of functional requirements	Are details about the implementation of one (or more) requirements you really like? Describe them!	-	Textual	No	No	-	

Reports

Do you like the proposed layout?

91

Exclusive  
choice

Yes

Yes

Outstanding



- Pretty nice but we think we have enhancements

Reports

In case you have comments on the layout  
please state them here:

-

Textual

No

No

-

- Building Manager should see the complaints/feedback of the habitants.

Complaints

Do you miss functionality about the complaints section?

91

Exclusive choice

Yes

Yes

Outstanding



- Yes, but only little points

Complaints

In case you miss something describe it here:

-

Textual

Yes

No

-

- The floors could be in the right order. Where are all these floors? How do I know where 12 is? Can each habitant see all the complaints or only his own?

UI	Do you like the graphical layout ?	51	Exclusive choice	Yes	Yes	Fair	
----	------------------------------------	----	------------------	-----	-----	------	--

- Very good!

UI	What you like about the graphical user interface?	-	Textual	No	No	-	
----	---	---	---------	----	----	---	--

UI	What you do not like about the graphical user interface?	-	Textual	Yes	No	-	
----	--	---	---------	-----	----	---	--

- Your corporate Logos.

General project process questions	Do you think we are engaged enough with the project compared to other external contractors you have hired?	44	Exclusive choice	Yes	Yes	Poor	
-----------------------------------	--	----	------------------	-----	-----	------	--

● You are in the upper half (>50%)

General project process questions	Would you hire us again?	91	Exclusive choice	Yes	Yes	Outstanding	
-----------------------------------	--------------------------	----	------------------	-----	-----	-------------	---

● Quite likely

General project process questions	How satisfied are you with the type and intensity regarding communication?	100	Exclusive choice	Yes	Yes	Outstanding	
-----------------------------------	--	-----	------------------	-----	-----	-------------	---

● We are aware that there were smaller issues. But we think this has not been more than usual

General project process questions	Would you have preferred to have more synchronization meetings?	88	Exclusive choice	Yes	Yes	Outstanding	
-----------------------------------	---	----	------------------	-----	-----	-------------	---

● No.

**Subject:** Re: We are live! (nearly)

**From:** Mathis Bramkamp <mathis.bramkamp@googlemail.com>

**Date:** 27.01.2016 15:55

**To:** thomas.kopp@stz-softwaretechnik.de, "jokscht@gmail.com" <jokscht@gmail.com>, "konrad.sagert@iao.fraunhofer.de" <konrad.sagert@iao.fraunhofer.de>, StefanWiedemann@live.de

**CC:** Dominic Zettl <dominic.zettl@stz-softwaretechnik.de>, master@matthias-gugel.de, antonio.pomarico@stz-softwaretechnik.de

Hi Thomas,

thank you for providing the website and some credentials to try it.

You'll find my detailed comments in the Statistica form but in general I can say you did a good job.

There was some error I got when I logged of and on again shown in the screenshot below.

### Server Error in '/' Application.

*The provided anti-forgery token was meant for a different claims-based user than the current user.*

**Description:** An unhandled exception occurred during the execution of the current web request. Please review the stack trace for more information about the error and where it originated in the code.

**Exception Details:** System.Web.Mvc.HttpAntiForgeryException: The provided anti-forgery token was meant for a different claims-based user than the current user.

**Source Error:**

An unhandled exception was generated during the execution of the current web request. Information regarding the origin and location of the exception can be identified using the exception stack trace below.

**Stack Trace:**

```
[HttpAntiForgeryException (0x80004005): The provided anti-forgery token was meant for a different claims-based user than the current user.]
System.Web.Helpers.AntiXsrf.TokenValidator.ValidateTokens(HttpContextBase httpContext, IIdentity identity, AntiForgeryToken sessionToken, AntiForgeryToken fieldToken) +618
System.Web.Helpers.AntiXsrf.AntiForgeryWorker.Validate(HttpContextBase httpContext) +71
System.Web.Helpers.AntiForgery.Validate() +92
System.Web.Mvc.ValidateAntiForgeryTokenAttribute.OnAuthorization(AuthorizationContext filterContext) +18
System.Web.Mvc.ControllerActionInvoker.InvokeAuthorizationFilters(ControllerContext controllerContext, IList`1 filters, ActionDescriptor actionDescriptor) +97
System.Web.Mvc.Async.<>_DisplayClass21.<BeginInvokeAction>b__19(AsyncCallback asyncCallback, Object asyncState) +743
System.Web.Mvc.Async.WrappedAsyncResult`1.CallBeginDelegate(AsyncCallback callback, Object callbackState) +14
System.Web.Mvc.Async.WrappedAsyncResultBase`1.Begin(AsyncCallback callback, Object state, Int32 timeout) +128
System.Web.Mvc.Async.AsyncControllerActionInvoker.BeginInvokeAction(ControllerContext controllerContext, String actionName, AsyncCallback callback, Object state) +343
System.Web.Mvc.Controller.<BeginExecuteCore>b__1c(AsyncCallback asyncCallback, Object asyncState, ExecuteCoreState innerState) +25
System.Web.Mvc.Async.WrappedAsyncVoid`1.CallBeginDelegate(AsyncCallback callback, Object callbackState) +30
System.Web.Mvc.Async.Async.WrappedAsyncResultBase`1.Begin(AsyncCallback callback, Object state, Int32 timeout) +128
System.Web.Mvc.Controller.BeginExecuteCore(AsyncCallback callback, Object state) +465
System.Web.Mvc.Controller.<BeginExecute>b__14(AsyncCallback asyncCallback, Object callbackState, Controller controller) +18
System.Web.Mvc.Async.WrappedAsyncVoid`1.CallBeginDelegate(AsyncCallback callback, Object callbackState) +20
System.Web.Mvc.Async.WrappedAsyncResultBase`1.Begin(AsyncCallback callback, Object state, Int32 timeout) +128
System.Web.Mvc.Controller.BeginExecute(RequestContext requestContext, AsyncCallback callback, Object state) +374
System.Web.Mvc.Controller.System.Web.Mvc.Async.IAsyncController.BeginExecute(RequestContext requestContext, AsyncCallback callback, Object state) +16
System.Web.Mvc.MvcHandler.<BeginProcessRequest>b__4(AsyncCallback asyncCallback, Object asyncState, ProcessRequestState innerState) +52
System.Web.Mvc.Async.WrappedAsyncVoid`1.CallBeginDelegate(AsyncCallback callback, Object callbackState) +30
System.Web.Mvc.Async.WrappedAsyncResultBase`1.Begin(AsyncCallback callback, Object state, Int32 timeout) +128
System.Web.Mvc.MvcHandler.BeginProcessRequest(HttpContextBase httpContext, AsyncCallback callback, Object state) +384
System.Web.Mvc.MvcHandler.BeginProcessRequest(HttpContext httpContext, AsyncCallback callback, Object state) +48
System.Web.Mvc.MvcHandler.System.Web.IHttpAsyncHandler.BeginProcessRequest(HttpContext context, AsyncCallback cb, Object extraData) +16
System.Web.CallHandlerExecutionStep.System.Web.HttpApplication.IExecutionStep.Execute() +412
System.Web.HttpApplication.ExecuteStep(IExecutionStep step, Boolean& completedSynchronously) +155
```

**Version Information:** Microsoft .NET Framework Version:4.0.30319; ASP.NET Version:4.5.114.0

Best Regards

Mathis

GFES - German Facility Engineering Solutions

*"Engineering made in Germany"*

Thomas Kopp <[thomas.kopp@stz-softwaretechnik.de](mailto:thomas.kopp@stz-softwaretechnik.de)> schrieb am Di., 26. Jan. 2016 um 20:18 Uhr:

Dear Gentlemen,

we are finally able to ship our product (at least in simulation mode since it is currently not possible to install the complete equipment and the software).

At <http://qb-hub.azurewebsites.net/Auth/Login> you can preview the shippable version of the software part.

Since we are excited to know if the product fully meets your requirements and expectations we would be pleased if you could give us feedback regarding our solution.

The questionnaire is already online at the known place and we are going to launch the website by Wednesday 27, 00:00:01 am.

To log in to the web site you will need following credentials

Login: root

pw: root123

or (for non-administrative view)

Login: flat311

pw : flat123

We hope we have met your expectations and we are looking forward to co-work with you again in the near future.

Greetings from

Thomas

on behalf of QB

PS: We are currently working on the latest UI tweaks like sorting and filtering for combo-boxes to enrich your experience.

PPS: You will find the reports at

<http://qb-hub.azurewebsites.net/Report/BuildingManager>,

<http://qb-hub.azurewebsites.net/Report/LocalAuthority> ,

<http://qb-hub.azurewebsites.net/Report/ResidentsCommitee>

#### 6.4 Conclusion on customer satisfaction tracking

Throughout the project it has been helpful to have additional input and the possibility to clarify some points to avoid or smooth out discordance regarding the one or other point. It has been also a positive experience to get a feedback to adapt the own development/behaviour in order to improve the relation to the customer and secure the success of the project.

## 7 Product development

**Author:** *Matthias Gugel*

**Contributor(s):** *Antonio Pomarico*

Customers kept asking for a simple, intuitive and unified user experience when interacting with any home automation system. To support a vast majority of home automation systems an abstraction of those systems is created. Through this abstraction layer the QB products are independent from the underlying systems. Therefore the desired user experience is made possible but on the other hand not every ingenious feature of every system is available. The customers feedback shows that most of the time only the basic features are used anyway and thus this trade off is positively accepted.

### 7.1 Concept

The main goal is an unified user experience across all the different home automation systems and any mobile device or computer. To accomplish this the products QB-Bridge, QB-Hub and QB-Home are developed with this goal in mind. The QB-Bridge provides an abstraction layer for the different home automation systems and QB-Home provides an unified graphical user interface across all mobile devices and computers. The whole communication between QB-Bridge and QB-Home is handled by QB-Hub. QB-Bridge, QB-Hub and QB-Home collaborate in a similar way to the MVC architectural pattern where QB-Bridge represents the Model, QB-Home the View and QB-Hub the Controller. This separation of concerns results in a modular software stack which in turn enables

improving a product without any impact on an other product. This is especially of high importance for QB-Bridge which is frequently updated to support the latest home automation systems.

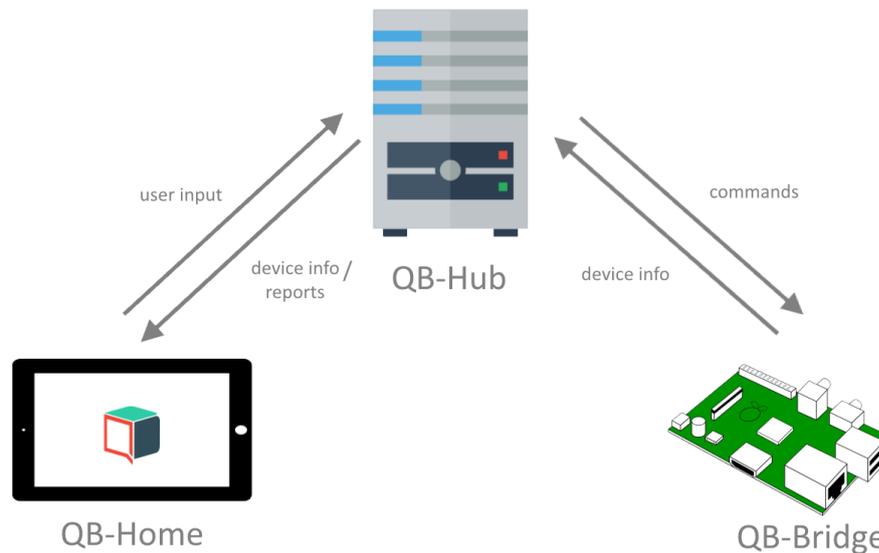


Figure 13: Development concept

In the following sections the development tasks for the products QB-Bridge, QB-Hub and QB-Home are outlined.

#### 7.1.1 QB-Bridge

The QB-Bridge provides an abstraction layer for the different home automation systems to the QB-Hub. Any home automation system can be supported as long as the devices controlled by the home automation system can be mapped to the device abstraction of QB-Bridge. In Figure 14 a subset of the supported device types is shown. The main task of the QB-Bridge is translation. The QB-Bridge translates every write and

read of the device state as well as every Update and Measure call on a device into the device specific API call. To turn on a Philips Hue Light resource for example the QB-Bridge receives an Update call on a specific device from QB-Hub with an Alteration object where the Property is set to "on" and the Target is 1.0. QB-Bridge translates this call into the following PUT request:

`https://<HUE>/api/<RESIDENT>/lights/<ID>/state {"on":true}.`

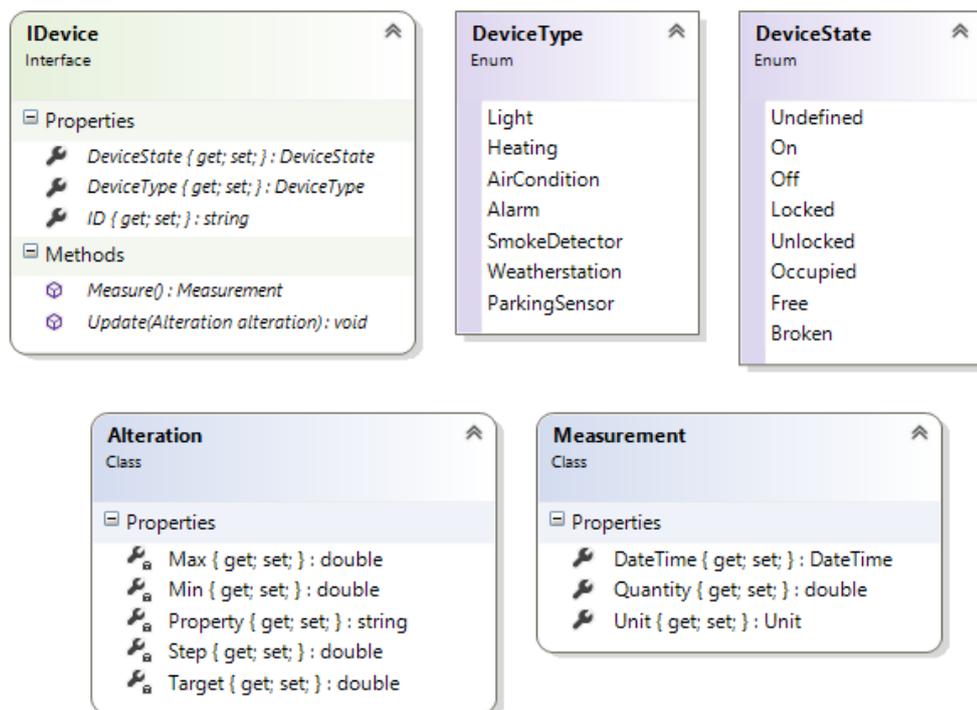


Figure 14: QB-Bridge device representation

The second task of QB-Bridge is to inform the QB-Hub about every alert automatically. As soon as a device like an alarm or a smoke detector is activated the QB-Bridge creates an Alert object (see Figure 15) holding the current time, the activated device, the severity of the alarm and a

message. This alert is then forwarded to QB-Hub.

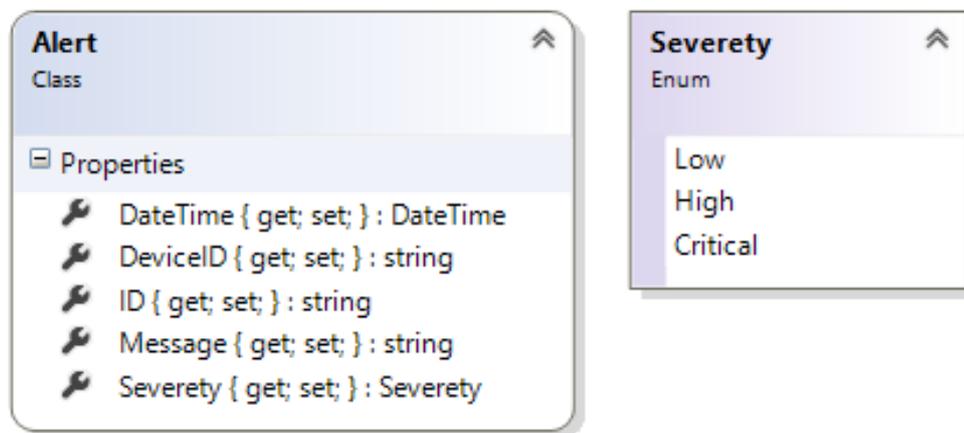


Figure 15: QB-Bridge alert

### 7.1.2 QB-Hub

The whole communication between QB-Home and QB-Bridge is processed by QB-Hub therefore QB-Hub can be seen as the central part of the QB software stack. On the one hand QB-Hub translates every user input from QB-Home into calls to the corresponding QB-Bridge system with the requested parameters and on the other hand every alert created by QB-Bridge is forwarded to QB-Home. This results in the complete separation of QB-Bridge and QB-Home. On top of the communication handling QB-Hub is responsible for the complete setup, authentication & authorization, report generation, alert & complaint management and providing QB-Home with prepared data. To accomplish this tasks QB-Hub uses a database back-end where all the required information is stored.

## Setup

Setting up the QB software stack involves configuring the installed QB-Bridges and optionally adding meta information to them and the connected devices. In order to use a QB-Bridge it has to be linked to at least one resident's account and given a location<sup>3</sup>. The location is a room with could also be inside of a flat (see Figure 16). Furthermore it is possible to assign speaking names to the QB-Bridge and every connected device<sup>4</sup>.

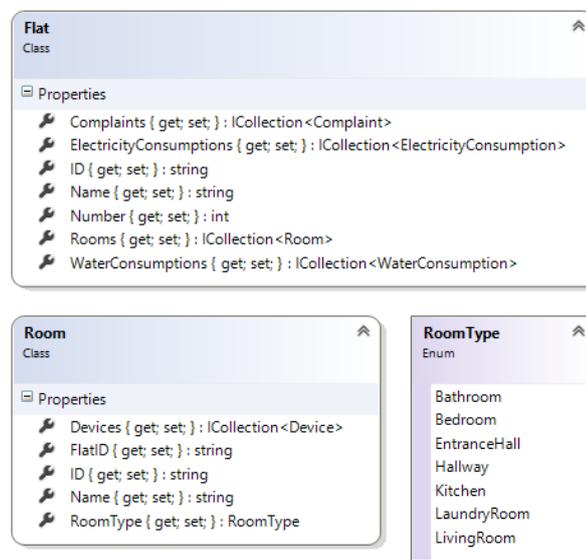


Figure 16: QB-Hub room representation

## Authentication & Authorization

For every resident and any party who should be able to view a report an account has to be created. An account links an ASP.Net Identity with a

<sup>3</sup>The location is important for eventually arising alarms. So that the source of the alarm can be determined instantaneously.

<sup>4</sup>This improves the user experience tremendously because the speaking name will be used in QB-Home instead of a technical ID

resident (see Figure 17). This account is used for authentication and authorization purposes only. This ensures that residents are only able to control and monitor their devices. And that any party is only able to access reports intended to the party in question.

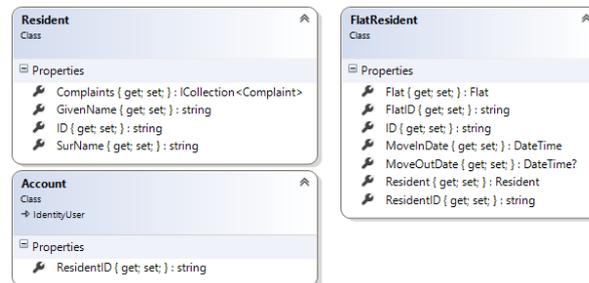


Figure 17: QB-Hub resident representation

### Report generation

Detailed report generation is a key feature of the QB software stack. To generate a report several measured values are gathered from the QB-Bridges and stored in the database. These values are prepared and forwarded to QB-Home as well as evaluated with a sophisticated heuristic to determine an ambient satisfaction. The ambient satisfaction is amongst other things determined by the requested device states and the actual device states. For example the room temperatures. To determine the overall satisfaction the ambient satisfaction and the feedback of a resident are evaluated. Every report is fully customizable in means of data which is shown and required access rights. Therefore privacy can be guaranteed by only allowing certain parties to view a report.

### Alert & Complaint management

All alerts and complaints are stored in the database (see Figure 18 for the

data which is stored for a complaint). This makes it possible to use them in the reports and to understand the issues helping to reduce the amount of complaints in the future. The complaint mechanism is an important way to increase residents satisfaction. When a resident has any problem with a device a complaint can be filled out without any hassle. This complained will be forwarded to a care tacker who will then decide on the best way to support the resident resolving the complaint. Alerts are directly forwarded<sup>5</sup> to the resident(s) which are affected by the alert and the responsible authorities.

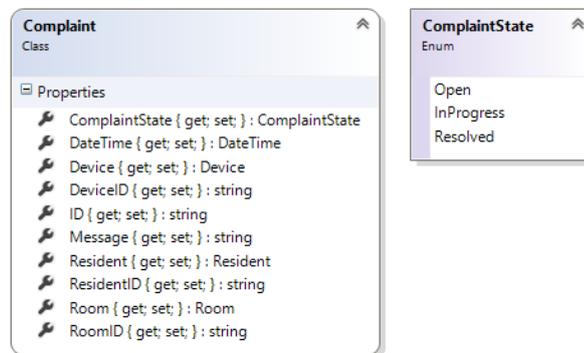


Figure 18: QB-Hub complaint representation

### Data preparation

Every information shown on QB-Home is prepared by QB-Hub in advance. The data fetched from QB-Bridge is extended with the location and the speaking names. The measured values for the reports are accumulated for the time range specified by the report to show. Last but not least the full name of the resident is provided to allow a personalized user experience.

<sup>5</sup>Residents using an app will get a push notification. For the other residents the alert will be shown on the home screen the next time they log in.

### 7.1.3 QB-Home

The sole responsibility of QB-Home is to provide an unified user experience over all mobile devices and computers. To be able to distribute QB-Home easily across various platforms the core of the application is a responsive website. With this approach it is possible to reuse the user interface for all platforms, follow the look and feel of the target platform while guaranteeing high usability and low development costs. The usage of a native app on a smart phone instead of the browser variant has the advantage that alerts can be received as push notifications.

The complete administration of the QB software stack can be performed through QB-Home. Arbitrary parties can be configured to have access to individualized and clean reports containing only information they really need. Moreover the residents use QB-Home to control and monitor their devices, file a complaint or provide feedback.

During development of QB-Home the focus stayed on the unified user experience. No matter which kind of home automation systems are used controlling and monitoring the state of the devices had to be as intuitive as possible. For the best outcome mockups where designed (see Figures 19-22) and given to those who will interact with QB-Home. The feedback collected continuously was used to further improve the mockups and finally to create the desired user interface. Therefore the feedback loop had a direct impact on the final design. Comparing the original mockups with the final design shows that the original mockups already met the expectations to a high extent.

The home screen shown in Figure 19 stayed basically the same. Only the "Go to the reports" link was removed. The same holds true for the devices overview (see Figure 20). Only some textual changes had to be accomplished.

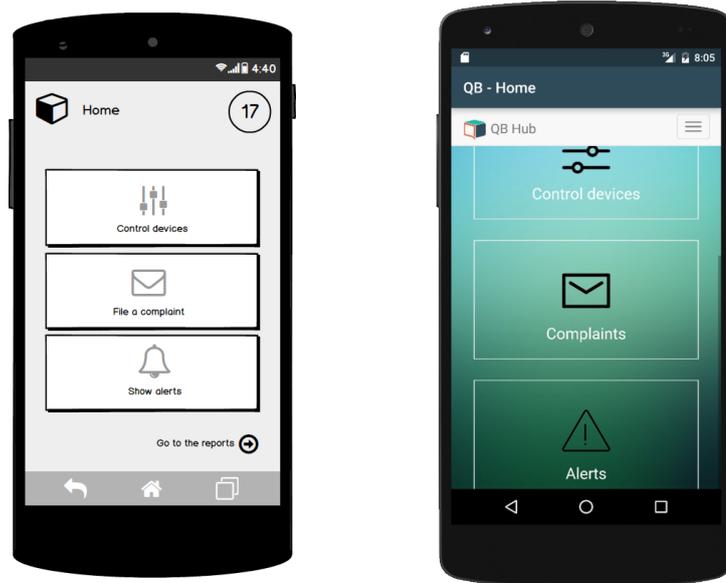


Figure 19: Home

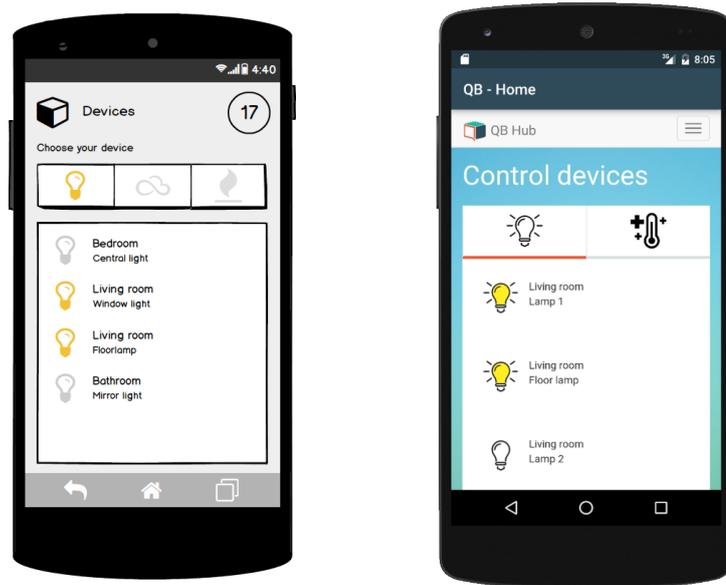


Figure 20: Devices

The complaints overview (see Figure 21) and the report screen (see Figure 22) show clearly that the users were striving towards an unified user interface.

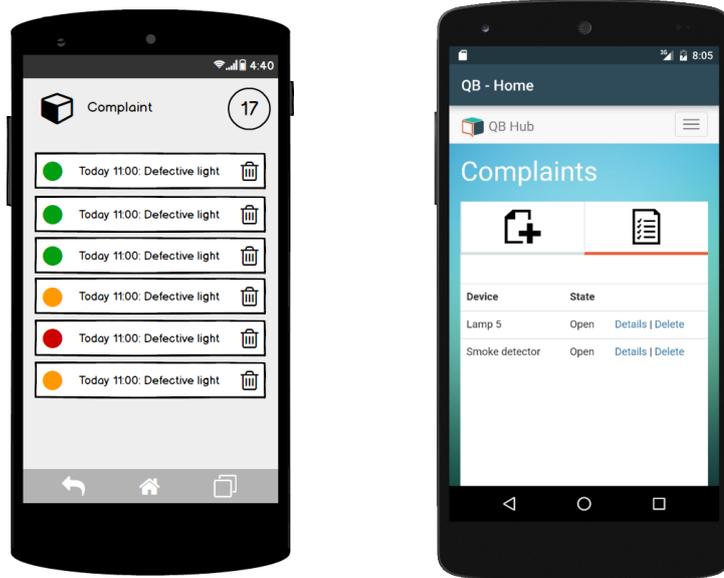


Figure 21: Complaints

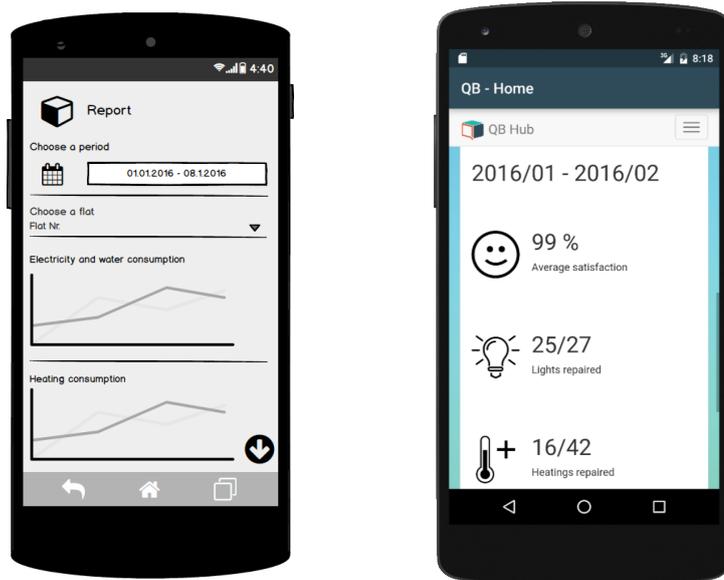


Figure 22: Report

## 7.2 Future features

During the development of the QB software stack one priority was to build it in such a way that it is feasible to develop new features. Having future features in mind required the development of the QB software stack to be in a modular way. Therefore the next version of the QB software stack will include following features already eagerly awaited by the customers:

- **Profiles**

With those profiles certain sets of device states can be assigned to a resident or a scenario. For example for the scenario tv certain lights can be dimmed, music turned off and the TV turned on.

- **ITTT**

With ITTT (If This Than That) rules can be defined which result in certain actions if an event occurs. With such a rule it is possible to demand the air condition to be turned off once a window is opened.

- **ACL**

With ACL (Access Control List) it is possible to define own access rights for every device. For example it is possible to prohibit turning on the TV for the child's account.

## 8 Conclusion

In this chapter every student wrote his own conclusion individually. Each conclusion will be displayed on a separate page.

### 8.1 Conclusion - Antonio Pomarico

I found the teamwork with my colleagues satisfactory. After the project was planned, the tasks were distributed to each team member. But, the role of the team members has not been assigned at the beginning of the project. Therefore, the tasks could be difficult allocated to the appropriate people. But through constant communication and the willingness to help each other, we were able to achieve almost our goals. Some team members were taken their skills not always serious and their ideas were not always involved. In my opinion, we would have a far obtained through the involve the ideas of better feedback for the design. Overall, I gained through this project a lot of experience in interpersonal relationships and also in project management.

## 8.2 Conclusion - Dominic Zettl

All in all the result of this project is very positive. Almost every requirement could have been implemented in the specified time. The solution of implementing the reports for the staff of the building in dynamic HTML was very good idea and probably adoptable for further projects. The work in the project were mainly periodically, this caused a more difficult planning of the project. A constant work, as in realistic jobs, could have been enabled a more precisely planning.

Tracking the tasks with Kanban worked very well, with this method the current state of the project could have seen very well. Write a common version based latex document was a well thought. In practice it made it more difficult due of merge conflicts. In the next project each member should write his own report document and merge at the end of the writing. The atmosphere in the team was very respectful and harmonic. It was very useful to have a team, which is working in the same company. Working next to each other helped to meet at the company spontaneously.

With the Statistica forms, a well structured customer feedback could be created and evaluated. Although it was very difficult to create a form it was very useful to remove misunderstandings of the customers' requirements. Furthermore it helped to get a feedback of the user interface mockup. During the project, there were also implementation tasks to do for the project manager. This was a nice mixture of implementing and planning the project. Although most of the decisions were made together, the responsibility for the team was very exciting. Summarized the role as a project manager was challenging but also exciting and for further projects very helpful.

### 8.3 Conclusion - Matthias Gugel

Despite all prejudices it was a quite interesting project. Even the fact that there was not a lot of time and the team has never worked together in this constellation before has not stopped the team from creating a first prototype and the result is quite astonishing. To accomplish this it was required by every team member to adapt fast to this new type of challenge. Neither one of us had any experience with project management. But in the end we learned a lot and everyone got a first impression on what it means to complete a project from the beginning to the end. There had been moments where it was unclear in which direction the project would head and what everyone had to do. This resulted in days spent talking past each other and the same work done by more than one person. If this project had to be done again it has to be ensured that the goal everyone is aiming for is crisp clear and of course the same for everyone. But due to the new gained experience this seems even likely to happen.

#### 8.4 Conclusion - Thomas Kopp

In general every project experience helps no matter if good or bad. So to see the project has helped a lot in terms of gaining a different view on project management. With a more detailed look there has been a lot of decisions and a growing understanding how difficult project management might be if not all (required) information is available. But like with every other project the decisions wouldn't be exactly the same. The major negative points have been the used Kanban board which has some major usability problems. These resulted in a break of the intended workflow which is proposed by Kanban. Another major negative point was the offered satisfaction tracking platform. It started with problems editing already created forms, continued with problems moving questions from section to section and in general the UI for creating new forms might need a rework. The last disappointment regarding this topic has been the fact that a form itself cannot be exported as pdf (questions and answers including weight/points) or something similar. But there are also positive points like the team, the gain experience and the possibility to do this in a secured environment. Some learning objectives might have been missed but with respect to the time which has been possible spending on the project the experience ratio is quite nice.



## 9 Appendix

### 9.0.1 Customer Requirements

#### Requirements

Lower Class (26 Rooms)	Upper Class (16 Rooms)
<ul style="list-style-type: none"> <li>• Floor Heating</li> <li>• Track Water (hot/cold) and Electricity per unit</li> <li>•</li> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• Window Detection System</li> <li>• Air conditioning per room</li> <li>• Display for door camera                             <ul style="list-style-type: none"> <li>○ Only active when door bell/intercom is used</li> </ul> </li> </ul>

General
<ul style="list-style-type: none"> <li>• Water Refreshing System                             <ul style="list-style-type: none"> <li>○ Ingress &amp; Egress Flow Rate Sensors (2x Flowrate Sensors)</li> <li>○ Fill level sensor</li> </ul> </li> <li>• Automatic Garden Sparkling</li> <li>• Solar Panels (Water + Electricity)</li> <li>• Post Box                             <ul style="list-style-type: none"> <li>○ Outsourcing to the Post office</li> <li>○ RFID integration onto SmartCard for identification</li> <li>○ Scale to measure the weight of content (output: empty or not)</li> </ul> </li> <li>• Anti-Burglar Alarm                             <ul style="list-style-type: none"> <li>○ 2 Front Doors</li> </ul> </li> <li>• Emergency Call System                             <ul style="list-style-type: none"> <li>○ 2 Button System over telephony system</li> <li>○ Tracking per telephony system who called when from where</li> </ul> </li> <li>• Fire alarm smoke detection system                             <ul style="list-style-type: none"> <li>○ How many smoke detectors needed?</li> </ul> </li> <li>• Camera observation at front doors                             <ul style="list-style-type: none"> <li>○ 2 cameras for security reason (IP Camera)</li> <li>○ Facility manager observes it</li> </ul> </li> <li>• Elevators                             <ul style="list-style-type: none"> <li>○ Outsourcing to an elevator company</li> </ul> </li> <li>• Two central Laundry rooms                             <ul style="list-style-type: none"> <li>○ Status of washing machines (busy/free)</li> <li>○ Connected to network</li> </ul> </li> <li>• Electronic Display in the Lobby                             <ul style="list-style-type: none"> <li>○</li> </ul> </li> <li>• Central telephone unit</li> <li>• Central door bell system</li> <li>• Motion based lighting</li> <li>• 3 charging stations                             <ul style="list-style-type: none"> <li>○ RFID identification</li> <li>○ Check status (free/busy) via power consumption</li> <li>○ Amperemeter between charging station and its connection to the power network. Amperemeter output is sent to the control network via LAN connection</li> </ul> </li> <li>• Water meter per flat                             <ul style="list-style-type: none"> <li>○ Water meter with M-Bus to read the water consumption</li> </ul> </li> <li>• Report system for habitants                             <ul style="list-style-type: none"> <li>○ Web GUI with report form</li> </ul> </li> </ul>

## 9.1 Reports

### 9.1.1 Importance of single contract/specification aspects V6

Created by: KoppT

Created on: 2015-12-30 11:34:18

Respondents:

### General Questions

**How important for you is to stay below the financial frame given?**

Type: Exclusive choice

CORE: yes

CORE mode: Ideal value (10)

Mandatory: yes

- Very important (10)
- Important (with possible negotiation if needed) (8)
- Important (if it can be reasonably argued) (6)
- Not so important (but not more than 10-15)

**How much coverage do you expected regarding your requirements?**

Type: Exclusive choice

CORE: yes

CORE mode: Ideal value (8)

Mandatory: yes

- Must be completely covered (100)

- Slight differences are okay ( 75
- Greater differences are okay but must be discussed (< 75
- Greater differences are okay and don't need to be discussed (< 75
- Requirements are only a guideline and might be considered or not (1)

**How important for you is being in time (Deadline 26th of January)?**

Type: Exclusive choice

CORE: yes

CORE mode: Ideal value (10)

Mandatory: yes

- There is no delay allowed. Must be on time. (10)
- Small delay is allowed but results in a fine. (8)
- Small delay is allowed without an additional fine. (7)
- Greater delay might be acceptable if the reasons can be explained. Only allowed if problems are communicated early. Will result in a fine. (5)
- Time is no matter (1)

**Reporting**

**In which format the reports shall be delivered?**

Type: Multiple choice

CORE: no

Mandatory: yes

- On a specific web page (1)
- By e-Mail (plain text) (2)
- By e-Mail (HTML formatted) (3)
- By e-Mail with report attached at pdf (4)
- PDF for download (5)
- By mail delivery (printed). Additional fees might occur due to postal charges (6)

**In your requirements you state that the system shall report how the residents' feedback has been handled? What do you mean exactly by that? What actions has been resulting from stating the feedback? How much the resident who handed in the feedback is satisfied with the outcome? Please provide a detailed description what you expect for this point regarding the content of the report.**

Type: Textual

CORE: no

Mandatory: yes

**For the local authority report it is necessary to provide a coloured rating for the consumption of electricity and water. But there is no mention of any threshold for a single or double bed room flat.**

Type: Exclusive choice

CORE: no

Mandatory: yes

- Yes we provide you with this thresholds. (1)
- No, just do like you want. (2)

### Surveillance cameras

#### What time frame shall be covered by the surveillance?

Type: Exclusive choice

CORE: no

Mandatory: yes

- 1 day (1)
- 2 days (2)
- 3 days (3)
- 7 days (1 week) (7)
- 2 weeks (10)
- 1 month (15)
- > 1 month (20)

#### Which medium shall be used for storing?

Type: Exclusive choice

CORE: no

Mandatory: yes

- Hard disk (1)

- Tape (5)

**Must the captured material be archived afterwards?**

Type: Exclusive choice

CORE: no

Mandatory: yes

- No (1)
- Yes (5)

**Which medium shall be used for archiving?**

Type: Exclusive choice

CORE: no

Mandatory: no

- Optical medium (CD, DVD, Bluray ..) (1)
- Disk storage (3)
- Disk storage with fail-over protection (RAID 1 or 5) (4)
- Tape (10)

**If archiving need to be performed for how long shall the archives go back?**

Type: Exclusive choice

CORE: no

Mandatory: no

- 3 months (3)
- 6 months (6)
- 1 year (10)
- > 1 year (15)

**If there is archiving where shall the material be archived?**

Type: Exclusive choice

CORE: no

Mandatory: no

- On site (highly not recommended) (1)
- Off site at our company (2)
- Off site at a different place (5)

**Alert handling**

**In which time frame a medium alert has to be handled (concrete solution might need little longer) ?**

Type: Exclusive choice

CORE: no

Mandatory: yes

- within 1 businessday (monday if alert was raised saturday) (10)
- within 2-3 businessdays (7.5)
- within 1 week (5)

- within 2 weeks (4)
- within 1 month (3)

**In which time frame a low level alert has to be handled (concrete solution might need little longer) ?**

Type: Exclusive choice

CORE: no

Mandatory: yes

- within 2 business days (10)
- within 3-5 business days (8)
- within 5-7 business days (7)
- within 2 weeks (5)
- within 1 months (3)
- 1-2 months (2)
- > 2 months (1)

**Laundry room**

**Is it necessary to have (recurring) reports about the laundry room (electricity/water consumption, ..) like the other reports?**

Type: Exclusive choice

CORE: no

Mandatory: yes

- Yes, monthly for the building manager (10)

- Yes, bimonthly for the building manager (7.5)
- Yes, once every 3 month addressed to the building manager (5)
- Yes, every half a year for the building manager (2.5)
- No (1)

### Further question on the system

#### Where shall the control system be hosted?

Type: Exclusive choice

CORE: no

Mandatory: yes

- On site (1)
- Off site at our company (2)
- Off site at another place (5)

#### How many days may a the system be not online?

Type: Exclusive choice

CORE: no

Mandatory: yes

- up to 12h (100)
- up to one day (90)
- up to two days (84)

- up to three days (75)
- up to 5 days (66)
- up to 1 week (60) up to two weeks (50) more than two weeks (35)

## Networking

Currently IPv6 cannot be utilized efficiently due to missing hardware (especially when going for sensors). Also most hardware capable of IPv6 is actually a combination of IPv4 and IPv6 - so called "dual stack" (IPv4 for private areas). This means that each flat will run IPv4 and the system IPv6. Recalibration to IPv6 only afterwards (if hardware is available) will result in massive costs (hardware replacement, installation, software reconfiguration). Currently we cannot recommend using IPv6.

Type: Exclusive choice

CORE: no

Mandatory: yes

- Yes, I accept that there will be nearly for sure a delay in development and I also accept an 75
- No, we are fine with IPv4 (1)

## Summary

How well are the requirements covered by the provided specification?

Type: Exclusive choice

CORE: yes

CORE mode: Lower limit (5)

Mandatory: yes

- We are completely happy having all requirements covered completely. (10)
- We are happy with your draft but have small recommendations. (7.5)
- We are quite happy but have recommendations for you. (5)
- We are not happy with the result. We need to negotiate again soon! (1)

9.1.2 UI questionnaire

Questionnaire regarding Ui mockups for building Project

Created by: KoppT

Created on: 2016-01-10 08:09:49

Respondents:

The pro side of the UI mockups

**Do you like what you see so far ?**

Type: Exclusive choice

CORE: yes

CORE mode: Upper limit (10)

Mandatory: yes

- This is exactly what we expected it should look like. PERFECT (10)
- We are really pleased by what you have done! (8)

- This is okay. Needs some improvement here and there. (5)
- Absolutely not that what we wanted. We need to meet as soon as possible. (1)

**Are there points/details you really like about our mockups? Describe as precise as possible please.**

Type: Textual

CORE: no

Mandatory: no

The downside of the UI mockups

**Are there points/details in the mockups you do not like ?**

Type: Exclusive choice

CORE: no

Mandatory: yes

- Yes (5)
- No (1)

**If there are points you do not like describe for us what it is. Please split up the text regarding the roles (resident, residents committee, building manager, caretaker)**

Type: Textual

CORE: no

Mandatory: no

### 9.1.3 Final evaluation

#### Rating for current product development V3

Created by: KoppT

Created on: 2016-01-22 10:40:24

Respondents:

#### Coverage of functional requirements

**How well are the functional requirements covered up to now?**

Type: Exclusive choice

CORE: yes

CORE mode: Lower limit (6.5)

Mandatory: yes

- Nearly to 100% (10)
- Around 75% (7.5)
- Half way through ( 50%) (5)
- We really need to talk - this is far not what we expected (below 33%) (1)

**Which functional requirements do you think need implementation refinements?**

Type: Textual

CORE: no

Mandatory: no

**Are details about the implementation of one (or more) requirements you really like? Describe them!**

Type: Textual

CORE: no

Mandatory: no

## Reports

**Do you like the proposed layout?**

Type: Exclusive choice

CORE: yes

CORE mode: Lower limit (7)

Mandatory: yes

- Excellent job (10)
- Pretty nice but we think we have enhancements (7.5)
- In general you are on the right track but we have changes (5)
- The layout needs a complete rework (1)

**In case you have comments on the layout please state them here:**

Type: Textual

CORE: no

Mandatory: no

## Complaints

**Do you miss functionality about the complaints section?**

Type: Exclusive choice

CORE: yes

CORE mode: Lower limit (7)

Mandatory: yes

- Yes (1)
- Yes, but you missed at least one major point. (5)
- Yes, but only little points (7.5)
- No (10)

**In case you miss something describe it here:**

Type: Textual

CORE: no

Mandatory: yes

UI

**Do you like the graphical layout ?**

Type: Exclusive choice

CORE: yes

CORE mode: Lower limit (7)

Mandatory: yes

- Far better than we could expect! (15)
- Very good! (10)
- We have small improvements (7.5)

- Not quite that what we expected. We have improvements (5)
- Absolutely not what we have expected. We need to talk! (1)

**What you like about the graphical user interface?**

Type: Textual

CORE: no

Mandatory: no

**What you do not like about the graphical user interface?**

Type: Textual

CORE: no

Mandatory: yes

General project process questions

**Do you think we are engaged enough with the project compared to other external contractors you have hired?**

Type: Exclusive choice

CORE: yes

CORE mode: Ideal value (10)

Mandatory: yes

- You are overperforming them (>100)
- You are within the top three ( 100)
- You are in the upper half (>50)
- You have to improve a lot to get out of that lower half (<50)

**Would you hire us again?**

Type: Exclusive choice

CORE: yes

CORE mode: Lower limit (7.5)

Mandatory: yes

- Definitely (10)
- Quite likely (7.5)
- Unlikely but possible (5)
- Definitely not (1)

**How satisfied are you with the type and intensity regarding communication?**

Type: Exclusive choice

CORE: yes

CORE mode: Upper limit (7.5)

Mandatory: yes

- You are doing great (10)
- We are aware that there were smaller issues. But we think this has not been more than usual (7.5)
- You should intensify your communication with your customers (5)
- We are totally not satisfied. We had to call everytime! (1)

**Would you have preferred to have more synchronization meetings?**

Type: Exclusive choice

CORE: yes

CORE mode: Ideal value (9)

Mandatory: yes

- No. (10)
- Maybe one more per development stage would have been nice. (7.5)
- Quite sure some more would have been helpful. At least mail/telephone conferences. (5)
- For sure. (1)