Detailed description of the “Housing problem in the Netherlands”

The data given in the description below are just examples. The model that has to be developed should contain parameters for these values.

A residential tower consists of several floors, e.g., 23, 40 or even 56 floors. The optimization model has to consider just one of these possibilities. Each floor can have apartments with different areas (e.g., 36, 42, 48, 52, 60, 68, 70, 71, 96, 131 m2). See also the two pictures on the next two pages. Since it is difficult to model which combinations of sizes can be combined in one floor, a complete list of possible floor designs is given. For example: 11 possible floor designs: aa, ab, ac, bb, bc, cc, cd, ce, dd, de, ee, where each floor consists of two parts, and in this example there are 5 possible parts:

Floor part a {36, 36, 42, 42, 48, 48}
Floor part b {42, 42, 52, 52, 58}
Floor part c {60, 60, 71, 71}
Floor part d {70, 96, 96}
Floor part e {131, 131}.

So, e.g., floor design “ab”, means 2 apartments of 36 m2, 4 apartments of 42 m2, 2 apartments of 48 m2, 2 apartments of 52 m2, and 1 apartment of 58 m2.

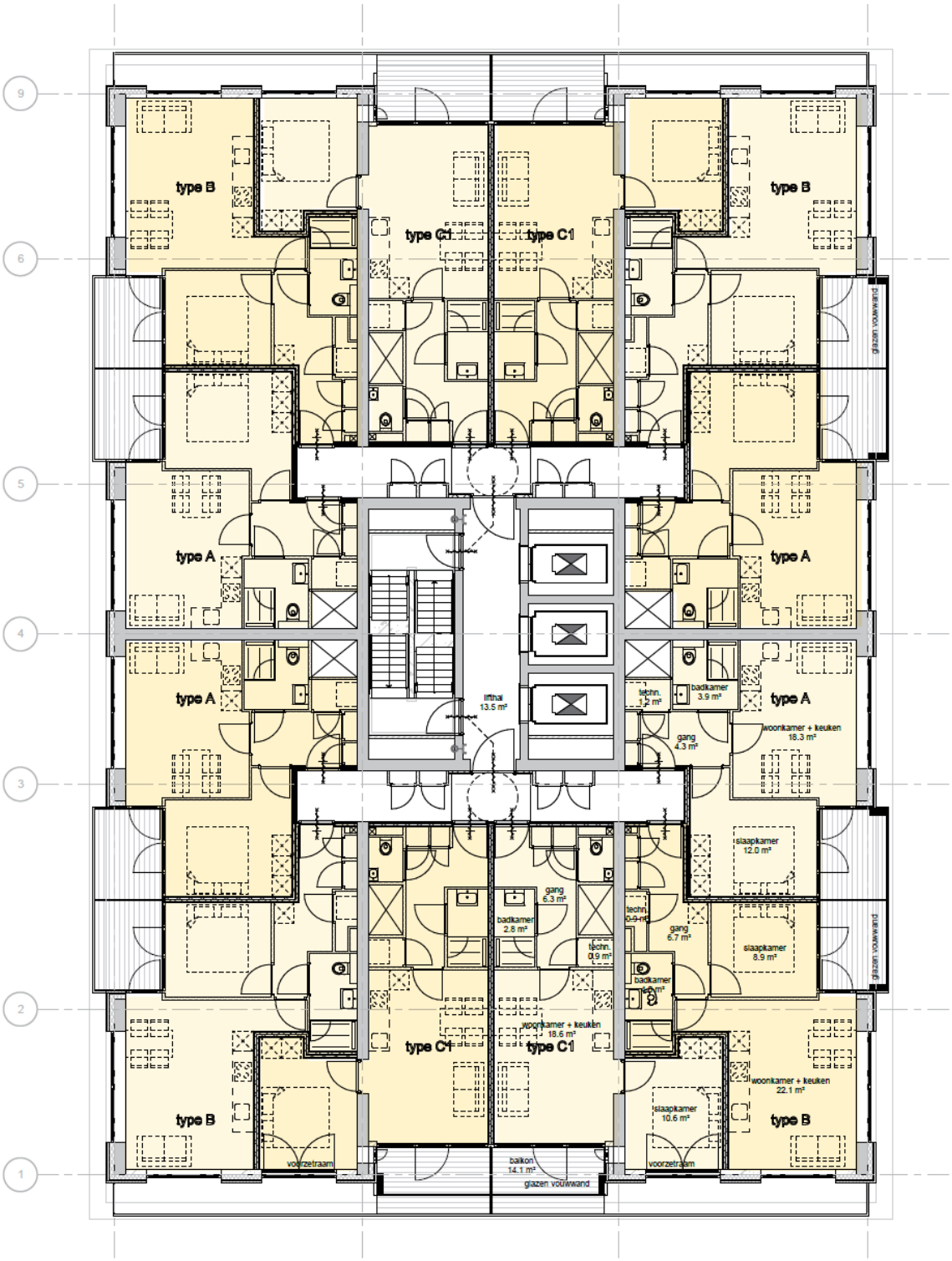
The owner of an apartment can be “corporation”, “investor”, or “private”. There are three important sectors: “social”, “middle”, and “free”. The profit per apartment for the real estate developer is given, and depends on the area of the apartment, the sector, and the owner.

Here are the design restrictions:

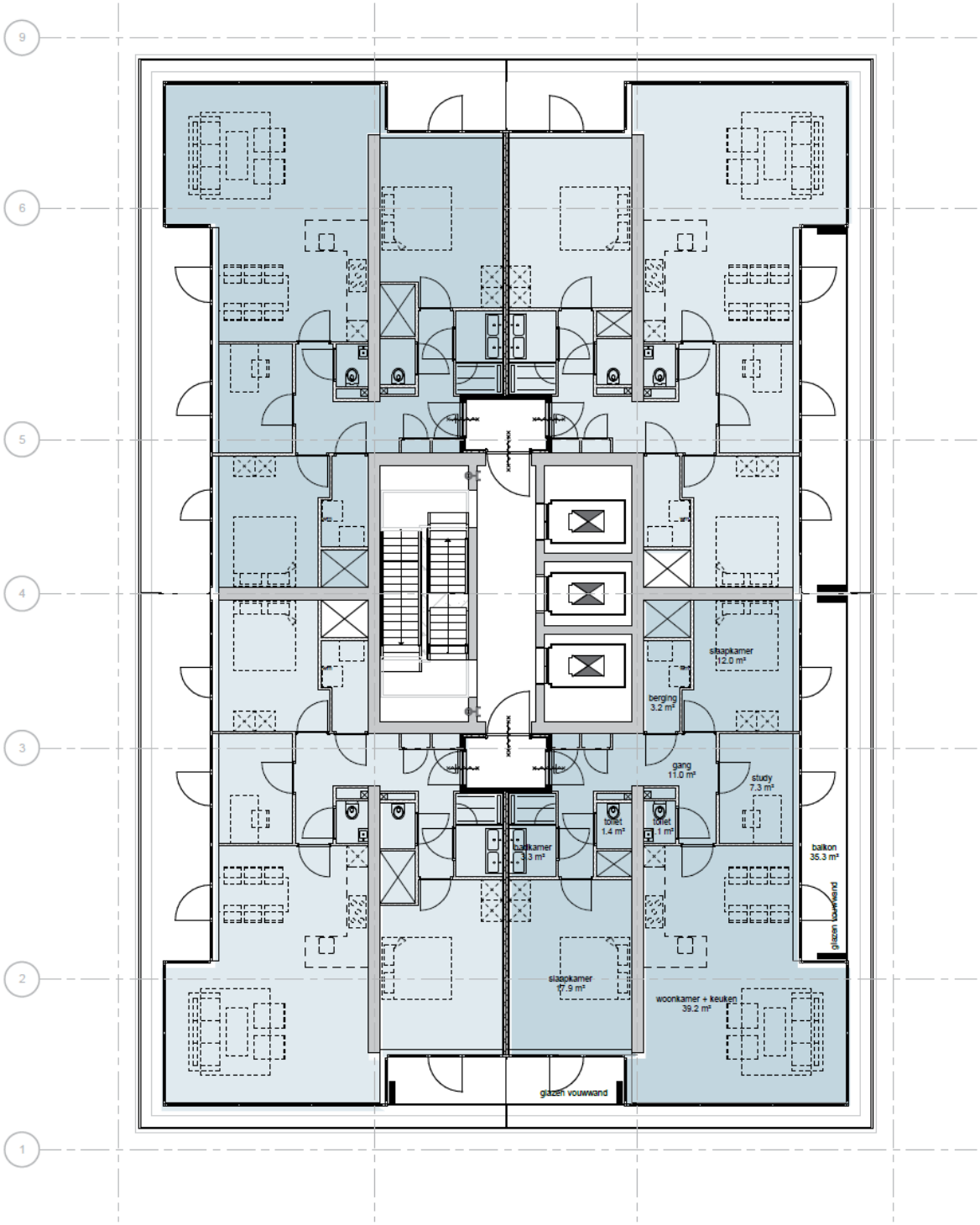
1. Percentage of apartments in “social” sector should be at least 40% of all apartments.
2. Percentage of apartments in “middle” sector should be at least 40% of all apartments.
3. The average area of a “social” apartment should be at least 40 m2.
4. The average area of a “middle” apartment should be at least 50 m2.
5. Minimal apartment area for “social” sector for corporation is 40 m2.
6. Minimal apartment area for “middle” sector for corporation is 50 m2.
7. Minimal area for “free” sector apartments is at least 60 m2.
8. The Corporation cannot buy apartments in the “free” sector.
9. Minimal 70% of apartments should go to “investors”.
10. All apartments on the same floor should be assigned to the same owner class (“corporation”, “investor”, or “private”).
11. An apartment in the “social” sector cannot be combined with an apartment in the “free” sector in one floor.
12. If the smallest apartment of a floor is smaller than the smallest apartment of another floor, then the floor number should be lower.

The aim of the real estate developer is to develop a design (i.e., which apartments on which floor, and for each apartment: which sector and which owner) such that the profit for the real estate company is maximized and all restrictions as described below are satisfied.

Develop an optimization model to find the best design. Clearly describe the sets, parameters, and variables used in the model. Try to keep the number of variables in the model as low as possible!



A floor with apartments of 3 different sizes: 4 apartments of type A, 4 apartments of type B and 4 apartments of type C1.



A floor with only apartments of one size: 4 apartments of the same type.