Advanced Analytics for a Better World

Optimised Housing Plan **Report**

Prepared By :

Domenica Valle
Neil Basson

Image generated by DALL-E

Introduction

Our team was assigned the task of finding the best design for an apartment tower. As we are data scientists, we made use of an optimisation model to find the maximum profit attainable, whilst keeping in line with the restrictions given to us.

In this report, a detailed description of the model is given as well as an analysis of the results. To further show the expected profit of the different tower sizes, certain restrictions were modified. This was done as it may be profitable for the company to relax some of the restrictions given to us, if these are not strictly needed.

Finally, our recommendation is given as to the best configuration of apartment sizes as well as an in-depth look at the tower of 23 floors, which shows the floor design, sector and owner assignment per floor.

Image generated by DALL-E

Model description

1 The goal of the model

The goal of the model is to maximise profit for a real estate developer building a residential tower. The model helps decide the best way to design the tower in terms of:

- How many floors the tower should have,
- Which design to use for each floor and how many apartments to include,
- Which type of owner will be assigned to each floor, and which sector each apartment will be assigned to.

2 Considerations of the model

The model takes into account several restrictions that must be followed when designing the building. These restrictions ensure that the building design meets certain regulations or market needs. For example:

1. Minimum apartment size: Different types of apartments must meet certain minimum area requirements.
2. Ownership requirements: Some of the apartments must be sold to investors, while others may be owned by housing corporations or private individuals. The model ensures that the right mix of ownership is achieved.
3. Floor design rules: Certain types of apartments cannot be placed on the same floor.

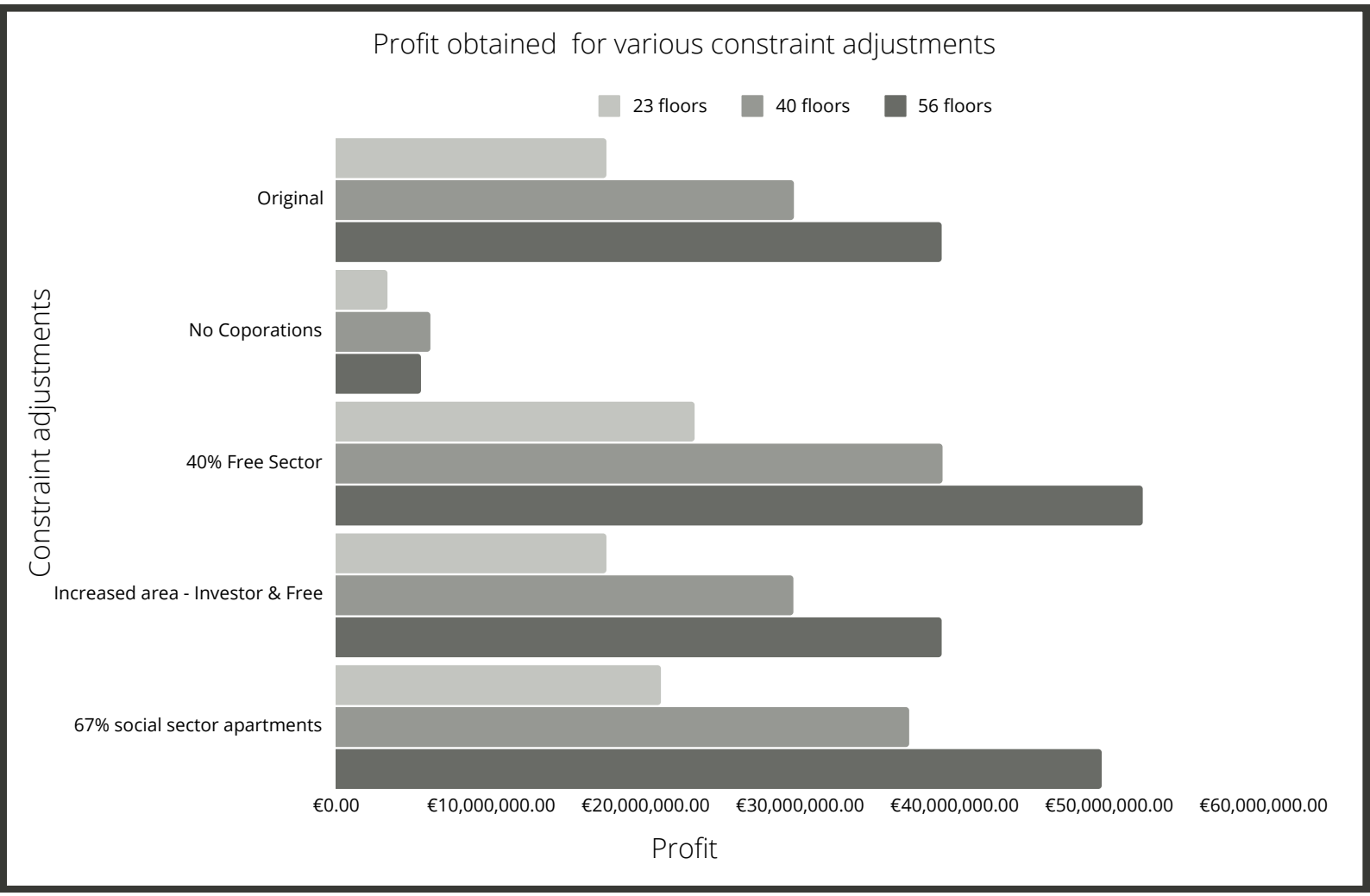
3 How does it work?

The model looks at three different building heights and calculates how much profit can be made for each height.

1. The model calculates the total profit for each possible building height.
2. It optimises the design by adjusting the number of apartments, the size of the apartments, and how the floors are organised.
3. It checks whether the design follows all the restrictions (e.g., apartment sizes and ownership rules).
4. Finally, it gives the most profitable design for the building while making sure all the rules are followed.

Results & Analysis

The original model, including all restrictions, generates high profits for all 3 tower sizes. To further test the strength of the optimisation model, and to allow for some modifications to the building plans, certain restrictions were relaxed or modified. This changed the expected profit for the different tower sizes. The magnitude of these changes is visible in the following chart.



The model we have built reached an optimal solution in which the total profits per building size are as follows:
€17.5 million for 23 floors, €29.6 million for 40 floors, and €39.2 million for 56 floors.

By adjusting various constraints, we can observe that altering certain parameters leads to an increase in profit. The figure above shows that by applying the minimum percentage of apartments to only the free sector—set to 40% of the total apartments—profit increases across all possible building sizes. The profit for 23 floors rises to €23.2 million (32.5% increase), for 40 floors it increases to €39.2 million (32.4% increase), and for 56 floors it increases to €52.2 million (33.16% increase).

If this constraint adjustment is not feasible due to government regulations, an alternative option is available. By setting the parameter to enforce that 67% of the total apartments belong to the social sector, the profit for each building size also increases. The profit for 23 floors rises to €21 million (20% increase), for 40 floors it increases to €37 million (25% increase), and for 56 floors it reaches €49.5 million (26.2% increase).

Detailed floor summary

Floor design summary (number of floors for each configuration):

Configuration aa: 11 floors
Configuration ac: 1 floor
Configuration cc: 1 floor
Configuration cd: 1 floor
Configuration ee: 9 floor

Apartment allocation summary (sector, area, owner, number of apartments):

Sector social, Area 36, Owner investor: 46 apartments
Sector social, Area 42, Owner investor: 27 apartments
Sector social, Area 60, Owner corporation: 2 apartments
Sector social, Area 70, Owner corporation: 1 apartment
Sector social, Area 71, Owner corporation: 2 apartments
Sector middle, Area 42, Owner investor: 19 apartments
Sector middle, Area 48, Owner investor: 46 apartments
Sector middle, Area 60, Owner investor: 6 apartments
Sector middle, Area 71, Owner investor: 5 apartments
Sector middle, Area 96, Owner corporation: 2 apartments
Sector free, Area 71, Owner investor: 1 apartment
Sector free, Area 131, Owner private: 36 apartments

Owner floor allocation summary (configuration, owner, number of floors):

Configuration aa, Owner investor: 11 floors
Configuration ac, Owner investor: 1 floor
Configuration cc, Owner investor: 1 floor
Configuration cd, Owner corporation: 1 floor
Configuration ee, Owner private: 9 floors

A table, showing the specific allocation of owner and sector per apartment per floor, is available in the appendix.

Image generated by DALL-E

Final Decision

It can be seen from the data provided in the figure that the profit obtained is directly proportional to the size of the building. The increased profit makes the option of choosing the largest possible building size very desirable, however, such a decision does not come without risks.

Larger buildings require larger upfront capital investments and longer construction periods, leading to greater financial risk exposure. With increased building size the risk of oversupply and meeting additional regulatory requirements is greater. Construction time is a vital factor in the decision-making process as selecting the smallest building size will result in a smaller profit, however, the timeframe for achieving a high ROI is decreased.

Ultimately the final decision for choosing a building size should consider all of the factors listed above and weigh them carefully to arrive at a well-reasoned decision.

Image generated by DALL-E

Appendix

Detailed floor summary of a 23 floor residential tower

Floor	Design	Owner	Sector Social	Sector Middle	Sector Free
1	aa	investor	$36m^2$: 4, $42m^2$: 4	$42m^2$: 4, $48m^2$: 4	
2	aa	investor	$36m^2$: 4, $42m^2$: 4	$42m^2$: 4, $48m^2$: 4	
3	aa	investor	$36m^2$: 4, $42m^2$: 4	$42m^2$: 4, $48m^2$: 4	
4	aa	investor	$36m^2$: 4, $42m^2$: 4	$42m^2$: 4, $48m^2$: 4	
5	aa	investor	$36m^2$: 4, $42m^2$: 4	$42m^2$: 4, $48m^2$: 4	
6	aa	investor	$36m^2$: 4, $42m^2$: 4	$42m^2$: 4, $48m^2$: 4	
7	aa	investor	$36m^2$: 4, $42m^2$: 4	$42m^2$: 4, $48m^2$: 4	
8	aa	investor	$36m^2$: 4, $42m^2$: 4	$42m^2$: 4, $48m^2$: 4	
9	aa	investor	$36m^2$: 4, $42m^2$: 4	$42m^2$: 4, $48m^2$: 4	
10	aa	investor	$36m^2$: 4, $42m^2$: 4	$42m^2$: 4, $48m^2$: 4	
11	aa	investor	$36m^2$: 4, $42m^2$: 4	$42m^2$: 4, $48m^2$: 4	
12	ac	investor	$36m^2$: 2, $42m^2$: 2	$42m^2$: 2, $48m^2$: 2, $60m^2$: 2, $71m^2$: 2	$71m^2$: 1
13	cc	investor		$60m^2$: 4, $71m^2$: 4	$71m^2$: 1
14	cd	corporation	$60m^2$: 2, $70m^2$: 1, $71m^2$: 2	$96m^2$: 2	
15	ee	private			$131m^2$: 4
16	ee	private			$131m^2$: 4
17	ee	private			$131m^2$: 4
18	ee	private			$131m^2$: 4
19	ee	private			$131m^2$: 4
20	ee	private			$131m^2$: 4
21	ee	private			$131m^2$: 4
22	ee	private			$131m^2$: 4
23	ee	private			$131m^2$: 4