

Advanced Analytics for a Better World

Assignment 3: Housing problem in the Netherlands

1 Introduction

This analysis aims to maximize profitability in residential development projects in the Netherlands while navigating housing regulations addressing the affordable housing shortage. The model optimizes configurations of residential towers with 23, 40, and 56 floors by analyzing apartment types, floor designs, and ownership allocations to comply with mandates on affordable housing proportions, apartment sizes, and ownership distribution.

Each floor is dedicated to a single ownership type, incorporating required percentages of social and middle-rental units to meet affordable housing mandates. The model adheres to average apartment size requirements for each sector, ensuring compliance with quality and space standards. Ownership models include housing corporations, investors, and private owners across social housing, middle-rental, and free-market units.

Additionally, the analysis explores an alternative scenario for the 23-floor configuration with relaxed regulatory constraints. This assesses potential increases in profitability and flexibility when requirements on affordable housing percentages, single ownership per floor, and apartment size mandates are less strict.

2 Analysis Results With Regulatory Restrictions

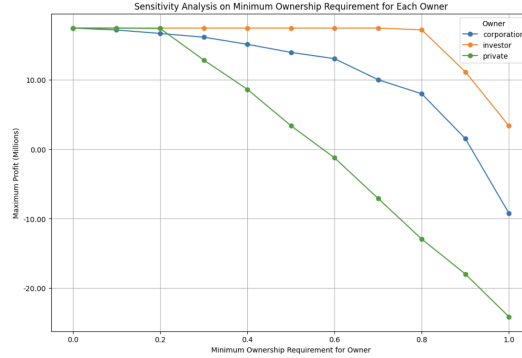
The optimal configuration for a 23-floor building achieves a projected profit of €17,483,910.86 by strategically assigning floor designs and ownerships to maximize returns within housing regulations. Private ownership focuses on premium free-sector units, particularly larger apartments, for higher profit margins, while housing corporations have minimal allocations due to lower profitability compared to investors and private owners. The ownership distribution is investors holding 56.5% of the floors, private ownership at 39.1%, and corporations at

4.3%. Apartment sectors are divided into 40.4% social, 40.4% middle, and 19.2% free-sector units. This layout prioritizes investor and private ownership to enhance profitability while balancing social and middle sectors to meet housing policy goals and optimize the financial structure.

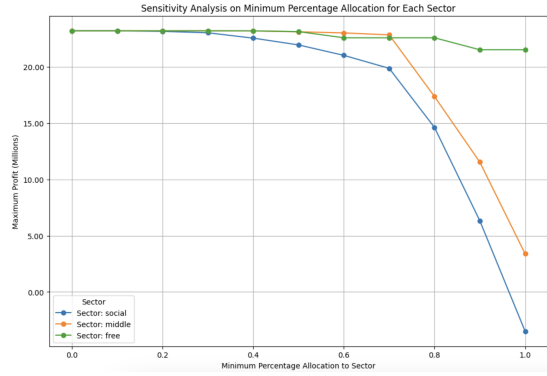
The 40-floor configuration maximizes profit to €29,622,229.85 by focusing on profitable floor allocations favoring investor and private ownership. Key to this strategy is the extensive use of designs "aa" and "ee," where investor-owned floors ("aa") and privately held premium floors ("ee") dominate, resulting in high returns. Investors primarily acquire floors with middle-sector apartments, optimizing revenue through mid-sized units offering favorable margins, while private ownership concentrates on larger, high-demand free-sector apartments. The ownership distribution is investors holding 57.5% of the floors, private ownership at 40%, and corporations at 2.5%. Sector distribution across apartments is 36.7% social, 45.2% middle, and 18.1% free-sector units. This distribution captures maximum profitability by aligning floor and apartment types with investor and private owner preferences, with a higher proportion of middle-sector units to optimize returns.

Lastly, the 56-floor configuration achieves a profit of €39,187,428.97 by emphasizing investor and private ownership across the layout. It relies on designs "aa" and "ee," allocating 25 floors to investors in "aa" and 23 premium floors to private ownership in "ee," both highly profitable. Investors focus on middle-sector apartments with mid-sized units yielding favorable margins, while private ownership is concentrated in spacious free-sector apartments, particularly the larger 131-square-meter layouts catering to high-end demand. The ownership distribution is investors holding 55.4% of the floors, private ownership at 41.1%, and corporations at 3.6%. Sector allocation across apartments is 40.1% social, 40.1% middle, and 19.8% free-sector units. This arrangement leverages investor and private preferences to maximize profitability while balancing social and middle sector requirements under regulatory constraints

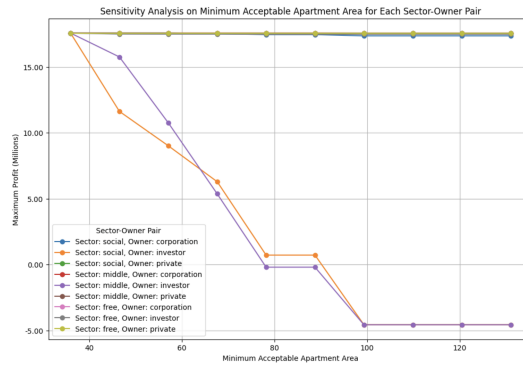
3 Sensitivity Analysis on Regulatory Restrictions for 23-floor buildings



Firstly, private ownership constraints have the most substantial impact on profitability. As the minimum ownership percentage for private owners rises, profitability experiences a sharp decline, especially beyond 50% ownership. This indicates that placing high minimum requirements on private ownership restricts the flexibility of the development, limiting the potential profit. To maintain higher profitability, it is advisable to keep the minimum ownership requirement for private owners below this 50% threshold. Investor ownership demonstrates a degree of resilience to ownership constraints, with profitability remaining relatively stable up to about a 60% minimum ownership requirement. Beyond this point, however, profitability begins to decline, indicating that while investor ownership can accommodate a moderate level of restriction, excessive requirements will negatively impact returns. Lastly, corporate ownership requirements also affect profitability, though with a gradual impact. Profitability decreases steadily as corporate ownership minimums increase, with significant effects appearing once ownership exceeds approximately 70%. For optimal profitability, it is crucial to maintain lower minimum ownership requirements for private owners (ideally below 50%) and to exercise flexibility in investor ownership, staying below 60% if possible. Corporate ownership can be moderately constrained, but minimizing these constraints further will contribute to maximizing overall returns.

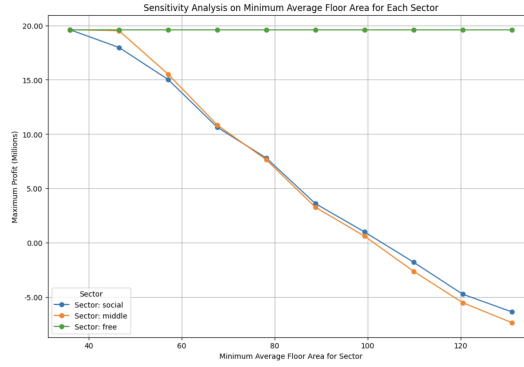


The analysis reveals that allocating a higher percentage to the social sector (blue line) results in the steepest decline in profitability. Profit levels start to drop notably once the allocation exceeds 40%, with a sharp reduction in profits as it approaches 100%. This indicates that strict requirements for social housing significantly limit profitability, as they impose higher constraints on the development. Similarly, middle-sector allocations (orange line) show a decline in profitability as minimum allocation increases, particularly beyond the 60% mark. While not as impactful as the social sector, high middle-sector requirements still reduce the flexibility needed to optimize profits. On the other hand, allocating to the free sector (green line) has a minimal impact on profitability, even at higher percentage requirements. Profit remains relatively stable across the range, suggesting that prioritizing the free sector can help maximize profitability, as it allows for more market-driven decisions.



This analysis shows that profitability is highly sensitive to minimum apartment area requirements in certain sector-owner combinations, particularly in the social sector with investor or private ownership. In these cases, profitability declines sharply when area requirements exceed 40 square meters, dropping to nearly zero by 80 square meters. The middle sector shows a similar but less pronounced trend, with profitability gradually decreasing as minimum area

increases. In contrast, the free sector remains largely unaffected by area requirements, maintaining profitability across a wide range of apartment sizes. To maximize returns, developers should prioritize flexibility in minimum apartment area for social and middle sectors, keeping these requirements relatively low. The free sector, however, can accommodate larger apartments without sacrificing profit, making it ideal for developments where market-driven, flexible unit sizes are preferred.



Profitability decreases significantly for both the social and middle sectors as the minimum floor area requirement increases. The decline becomes more pronounced beyond 40 square meters, with profits falling steeply as the area requirement approaches 120 square meters. This indicates that larger average floor areas in these sectors heavily constrain profitability, likely due to higher construction and allocation costs that limit flexibility. In contrast, the free sector shows remarkable stability, with profitability remaining unaffected across all floor area requirements. This suggests that developments focused on the free sector can accommodate larger average floor areas without compromising profit, making it advantageous for projects where higher floor area specifications are desired. For optimal profitability, minimizing floor area constraints in the social and middle sectors is crucial. The free sector, however, offers greater adaptability, allowing developers to maximize returns even with larger unit sizes.

4 Conclusion

Restricting or constraining flexibility in ownership distribution and sector allocations limits profitability. For example, stringent requirements in the social and middle sectors reduce returns by forcing allocations that may not align with optimal profit outcomes. Prioritizing premium free-sector units for private ownership and mid-sized units in the middle sector for investor ownership has been shown to enhance profitability within these constraints. Relaxing regulations in the 23-floor configuration shows potential for increased profitability, demonstrating that greater flexibility in ownership and apartment size requirements can enhance returns.