

Modelling Milieu-specific Housing Demands for Augsburg Oberhausen using BPD-MOSAIC

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1 INTRODUCTION

Planning and developing new residential areas is a knowledge-intensive and challenging undertaking. One particular challenge is to adequately anticipate both the quantitative and qualitative needs and preferences of the future residents early on in the planning process. At such an early stage it is usually not possible to know exactly who the future residents will be and therefore hardly feasible to take individual housing needs and preferences into account. Formulating a comprehensive vision statement that serves as a guideline for the development of the new residential area is therefore of utmost importance. Drafting such a statement requires the developer to address a number of issues: Who could be the future residents? What are their socio-demographic characteristics? What target groups should be addressed? What are their housing needs and preferences? Which conceptual requirements result from this for the planning of the future residential area?

Answering such questions requires an in-depth understanding of local and regional housing demand dynamics. While housing demand statistics provide a rough estimate as to how much new construction is needed to meet the existing demand for housing, they tell us very little about who the future residents might be and what qualitative requirements they have. To fill this gap, the area developer Bouwfonds Property Development has developed a model called BPD-MOSAIC. The model, which builds on a geodemographic data set, is a tool to assess the potential housing demand for a specific residential project by identifying target groups together with their typical housing needs and preferences, and forecasting the probability of these groups moving in. The findings should help to develop and market the future residential area according to the needs and preferences of particular target groups, and thereby reduce the risk of maldevelopments. Using Augsburg Oberhausen as an example, the following paper aims to discuss the capabilities and constraints of the model as a data-driven decision-making support tool for planning new residential areas.

Keywords: housing demand, residential development, geodemographic model, MOSAIC, milieu

2 METHODOLOGY

The model draws on a comprehensive database made up of primary and secondary data, which are then analysed using a sequence of computational operations. The following section will first address the configuration of the database used in the model and then proceed with a brief description of the different calculation procedures.

2.1 Data preparation

For the model calculation, an extensive database has been compiled from several data sources. At the core of this database lies the MOSAIC data set developed by the commercial data provider EXPERIAN, which holds geodemographic information on more than 42 million households in Germany. To ensure data privacy, EXPERIAN's data has been aggregated at a building level. This guarantees that information cannot be attributed to an individual household. Using geodemographic information such as age, household size, income, education, consumer behaviour, as well as residential location and building type, the aggregated households are clustered into milieu groups of similar geodemographic characteristics (EXPERIAN, 2014). The cluster algorithm used by EXPERIAN classifies the households into a total of ten milieu groups, which again are divided into subgroups (Table 1). Altogether, this allows the assignment of a specific milieu group to 22 million addresses in Germany.

Based on the geodemographic characteristics of the different milieu groups, some conclusions can already be drawn regarding both, housing needs (household size, age, salary) and preferences (inner city, suburban location, rural area). To gain a deeper understanding of how the housing needs and preferences differ between and within the various milieu groups, a telephone and internet-based household survey was conducted in cooperation with the market research company USUMA. Altogether, around 24,000 households were interviewed throughout Germany. The survey involved questions about the desire to relocate, preferred residential location, and the appearance of buildings and their surroundings. To link the survey results to

specific milieu groups, the respondents were also asked to state their current address. Overall, 70% of the respondents have been assigned to a corresponding milieu group.

Group	Name	Group	Name
A	The Upper Class	E2	Low-Income Dwellers in Disadvantaged Regions
B	Established Suburbanites	F	Traditional Elderly People
C1	Successful Urbanites	G	Baby Boomers in Stable Region
C2	Young Digital Academics	H1	Suburban Families
C3	Urban Middle Class	H2	Families in Stable Regions
D1	Metropolitan Workers Milieu	H3	Traditional Rural Families
D2	Urban Low-Income Dwellers	I	Rural Dwellers in Stable Economic Conditions
D3	Low-Skilled Achievers	J	Rural Low-Income Dwellers
E1	People Affected by Structural Change	U	Unknown Milieu

Table 1: MOSAIC milieu-groups

Given that the MOSAIC dataset itself only provides information on where certain milieu groups live, but not from which milieus households are relocating, the MOSAIC dataset was supplemented by a relocation dataset provided by EXPERIAN. The data set includes address information of origin and destination for a total of 22 million relocation movements made between 2012 and 2018. As these account for only half of all relocation movements within Germany, the data set has been calibrated using the migration statistics of the Federal Statistical Office. By joining the milieu and relocation data set, relocation flows can be analysed both in terms of their size and milieu-specific composition.

2.2 Data analysis

Data analysis is performed using the SPSS statistics software. In a first step, a target area is defined upon which the analysis is performed. This could be, for example, the district in which the future housing project will be located. It is important that the target area is chosen in such a way that there is a spatial-structural relationship. However, from a structural perspective the target area should neither be too homogeneous nor too heterogeneous. For the case presented in this paper the postal code area 86254 is used as a target area, covering the southern part of Augsburg Oberhausen. For the defined target area, the following probabilities were then calculated for all of the 22 million households:

- P1: The probability of a household relocating within the next year.
- P2: The probability of a household relocating into a certain property type (new/old building, single-family house/multi-family house), type of ownership (property/rent) and residential location (city centre, urban area, outskirts, periphery).
- P3: The probability of a household relocating to the defined target area.
- P4: The probability of a household having a certain preference (facade design, number of parking spaces, size of apartment, etc.)

While the probabilities P1 and P2 are calculated using a binary logistic regression method, P3 and P4 represent empirical values. By summing up the expected values (P1, P2, P3, P4) for each of the 22 million households, the results yield information on relocation flows to the previously defined target area. The calculated flows can then be broken down both by target groups (milieu, income, age groups, household sizes) as well as preferred and actually chosen housing types (single-family house/multi-family house, new buildings/old buildings), allowing the user to draw conclusions about the location-specific housing demand potential. In other words, using the cumulative expected values, the model can be used to calculate the probability of households living in Munich to relocate to a multi-family home in Augsburg Oberhausen.

3 RESULTS

For Augsburg Oberhausen (86254) the probabilities P1, P2 and P3 have been calculated. The results of the MOSAIC model calculation will be presented in the following section.

3.1 Which target groups live in Oberhausen und which are moving in?

A look at the milieu structure of Oberhausen (86254) shows that with a share of 84.3%, the D1-milieu accounts for the largest proportion of households (Fig 1). The D1-milieu is generally made up of industrial workers, living in prosperous and industrially dominated conurbations. These households are usually made up of singles or patchwork families living in rented apartments, predominantly in historic inner-city locations or large-scale housing estates. Households in this milieu group tend to be low-educated and earn modest incomes. Furthermore, this milieu group relocates relatively often. The second most common milieu group in Oberhausen (5.9%) - the Urban Low-Income Dwellers (D2) - shows an equally high relocation frequency. Similar to the D1-milieu, the D2-milieu is characterised by relatively low incomes and low-levels of education. Both milieu groups are also very similar in terms of household composition and residential location. However, a key difference lies in the generally younger age of the D2-milieu compared to D1. An examination of the milieu composition of the city of Augsburg as a whole shows that the D1 and D2-milieu not only plays a dominant role in Oberhausen, but in the city as a whole. At the same time, it becomes apparent that other milieu groups living in Augsburg, such as the milieu of the Urban Middle Class (C3), the Young Digital Academics (D2), or the financially much better-off Successful Urbanites (C1) and Established Suburbanites (B), are almost absent in the target area Augsburg Oberhausen. These findings indicate that Oberhausen (86254) constitutes, at least from a socio-demographic perspective, a relatively segregated part of Augsburg.

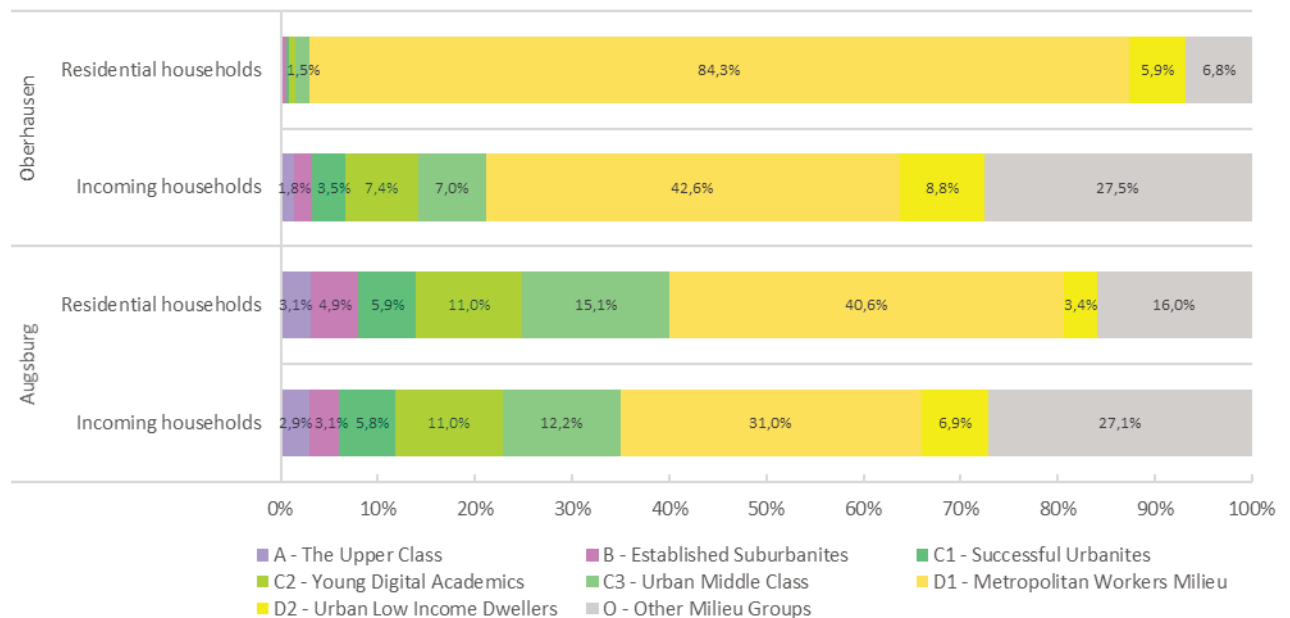


Fig. 1: Milieu composition of residential and incoming households in Oberhausen and Augsburg.

A look at the milieu groups of the households relocating to Oberhausen reveals that also among the incoming households the D1 and D2-milieu plays a key role, with shares of 42.6% and 8.8% respectively. However, an influx of other milieu groups can also be observed. Around 7% of incoming households belong to the Urban Middle Class (C3), which represents a very broad sociodemographic group in terms of age, household size, income and educational background. Also Digital Young Academics (D2) are relocating to Oberhausen (7.4%). These are typically students or households pursuing a rather student-like or alternative lifestyle. Being a university city, this group plays a relatively large role in Augsburg as a whole, although it is only sparsely represented in Oberhausen. On the whole, however, the influx of these milieu groups indicates a tendency towards an increasing diversity within the milieu structure of Oberhausen.

3.2 Where do the households moving to Oberhausen come from?

The analysis of relocation movements shows that between 2012 and 2018 around 15,228 households relocated to Augsburg, of which about 10% (1,523) relocated to Oberhausen. Around 23% of the relocations to Oberhausen represent internal relocations within the postal code area 86254 (Fig 2). A further 34% relocated from other parts of Augsburg. Thus, the share of intra-city relocations to Oberhausen amounts to a

total of 57%. However, this comparatively high proportion is by no means unusual for a large city like Augsburg with a population of around 300,000. The results indicate that Oberhausen as a residential location is not only of local, but also of regional and even nation-wide significance. 13% of the households that relocated to Oberhausen between 2012 and 2018 came from the neighbouring counties Augsburg and Aichach-Friedberg, with the county of Augsburg playing a key role as a place of origin (10%). Furthermore, more than a quarter of households originated from municipalities located in the rest of Germany, with southern Germany accounting for a share of 19%. The City of Munich, on the other hand, plays a rather minor role as a place of origin (3%).

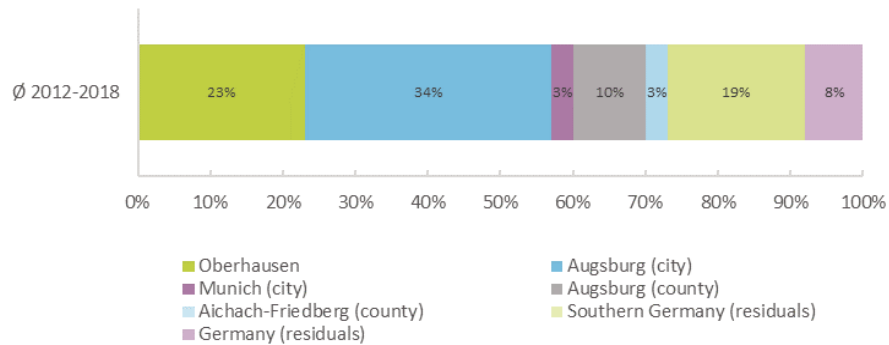


Fig. 2: Origin of households relocating to Oberhausen (2012-2018).

3.3 What is the regional probability of a household relocating to Oberhausen?

The results of the calculations P1 (the probability of a household relocating) and P2 (the probability of a household relocating to the target area) are illustrated in Figure 3. The findings show, that households living in the target area or in the adjacent postcode areas show the highest probability of relocating to Oberhausen (86254) within the next year ($P > 0.05$). Households from the remaining areas of Augsburg show a slightly lower probability ($P 0.02-0.05$). The same applies to households living in the eastern municipalities of Augsburg county. By contrast, households from the county Aichach-Friedberg are much less likely to relocate to Oberhausen ($P 0.005-0.02$). Overall, the results show that the probability of a household moving to Oberhausen decreases with increasing distance to the target area.

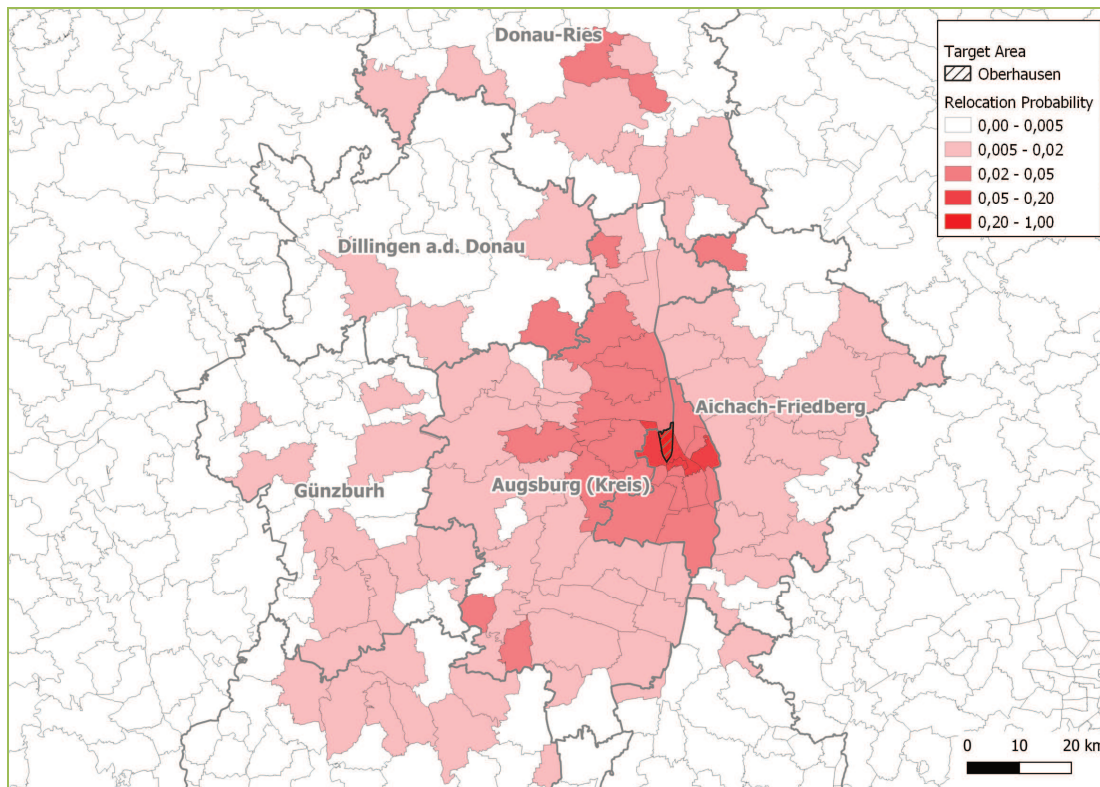


Fig. 3: Regional probabilities for a household relocating to Augsburg Oberhausen.

3.4 Which housing types are preferred among households relocating into new residential properties?

The calculation of the cumulative probabilities $P1+P2+P3$ shows that out of the total of 1,523 households that relocated to Oberhausen between 2012 and 2018, only 81 relocated into newly built residential properties (<3 years). At 54%, small multi-family houses with three to four units accounted for the largest share of relocations to new residential properties. A respective 18% moved into one- and two-family houses as well as medium-sized multi-family houses with five to ten units. On the other hand, only 9% of households relocated to large multi-family houses with more than ten units.

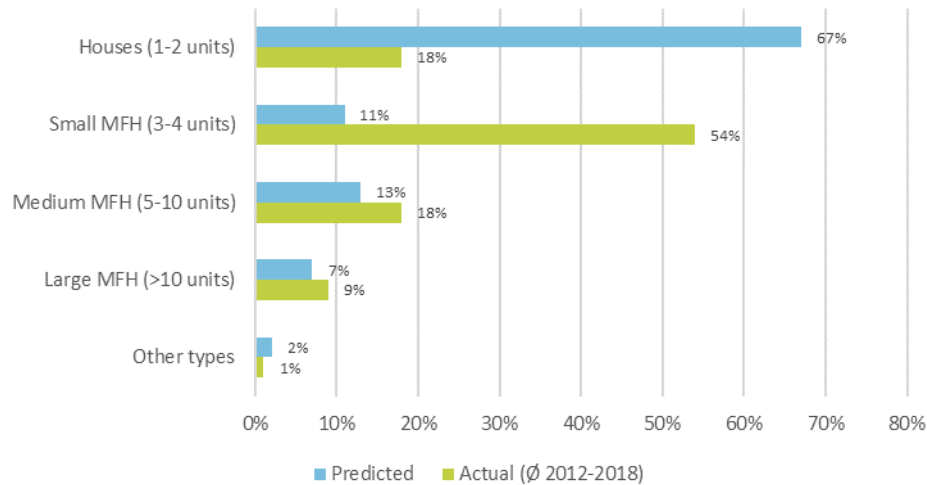


Fig. 4: Actual and predicted relocations to newly built properties in Oberhausen by housing type (2012-2018).

A comparison of the empirical values obtained from actual relocation movements (2012-2018) with the values obtained from the model (which takes into account the milieu-specific housing preferences) reveals some substantial discrepancies. The model assumes that 67% of the households moving to Oberhausen would move into newly built one- and two-family houses, as a result of their milieu-specific housing preferences. The opposite is expected for small multi-family houses. In this case, the model calculates a share of only 11%, which turns out to be significantly lower than the 54% of actual relocations to newly built small multi-family houses between 2012 and 2018. However, for medium-sized ($\Delta=5\%$) and large multi-family houses ($\Delta=2\%$) the difference between empirically observed and modelled values turns out to be considerably smaller.

4 DISCUSSION

The results of the analysis revealed that the target area Augsburg Oberhausen (86254) represents a classic working-class district. Furthermore, the analysis showed that also among the households relocating to Oberhausen the D1 and D2-milieu plays a prominent role. However, there are also households from the A, B and C-milieu relocating to Oberhausen. Due to the large proportion of the D-Milieu in Oberhausen and its above-average relocation frequency, it can be assumed that a considerable share of the relocations movements of this milieu group are attributable to internal relocations. The opposite can be assumed for households from the A, B and C-milieu. Given that these milieu groups make up only a small proportion of the population of Oberhausen, it can be assumed that the relocations movements of this milieu group are mainly attributable to relocations originating from outside of Oberhausen. The influx of these milieu groups may result in a greater diversity within Oberhausen's milieu structure. However, the D-Milieu will certainly remain the dominant milieu group in Oberhausen.

Based on the milieu structure of the households living in and relocating to Oberhausen, a strong overall demand for low- to middle-income housing can be expected. At the same time, it must be assumed that there is an elevated demand for rental apartments suitable for small to medium-sized households. Despite the D1-milieu's strong preference for rental housing, there is also a significant proportion of households within this milieu group with a desire to own property. However, in order to serve this target group in the owner-occupied segment, it is necessary to develop an affordable product suitable for this group. Since financially

well-off milieu groups such as the A, B and C1-milieu only relocate to Oberhausen to a limited extent, restricted demand for high-priced housing can be expected.

Regarding the question which housing types are being preferred among those household relocating into new residential properties in Oberhausen the model does not provide a clear answer. Partly the results show significant discrepancies between the empirical and modelled values for relocations to newly built one and two-family houses as well as small multi-family houses. Despite their expected milieu-specific preference for one and two-family houses, households relocating to Oberhausen rather opt for multi-family houses, particularly for small multi-family houses. This raises the question of whether these households would actually have preferred to relocate into one and two-family houses, but instead relocated into multi-family houses as a result of an inadequate supply. Another explanation would be that within the respective milieu groups the preference for one and two-family houses is not as high as the survey results and geodemographic characteristics would suggest. Indeed, the high preference for one and two-family houses among the D1-milieu is a phenomenon specific to Bavaria. Unlike in other parts of Germany, in Bavaria the D1-milieu lives unusually often in one and two-family houses, despite their predominantly urban living environment. This might be explained by the circumstance that, because of their comparatively low incomes, this milieu group often settles in suburban areas in order to avoid the high housing costs in the inner-city locations of Bavarian cities. In the suburbs, the D1 milieu then encounters a housing supply consisting mainly of one and two-family houses. Due to this peculiarity, it must therefore be assumed that in a metropolitan location such as Augsburg the preference of the D1-milieu for one and two-family houses must be lower than in the aforementioned suburban locations. However, in order to solve this issue it is necessary to recalibrate the housing preferences of the different milieu groups according to the varying local conditions.

5 CONCLUSION

As the example of Augsburg Oberhausen shows, BPD-MOSAIC provides in-depth insights into local housing demand structures. Using the MOSAIC milieus developed by EXPERIAN, the model allows to identify potential target groups and draw conclusions about their housing needs and preferences based on their geodemographic characteristics. In so doing, the model goes far beyond the static nature of the milieu approach by exposing the relocation movements of the different milieu groups and thus providing important insights into their relocation behaviour. Thereby the milieu approach acquires a spatio-temporal dynamic. By combining the milieu and relocation data set with the findings of a housing preference survey, milieu-typical housing preferences and actually made housing choices can be compared. Using these information, the different needs and preferences of potential target groups can be integrated into the planning process at an early stage. The model thus offers a promising approach to plan and develop residential environments that are in line with the actual housing needs and preferences of their future residents, while at the same time reducing the risk of maldevelopments. These capabilities and its localized approach make BPD-MOSAIC a promising tool for data-driven decision-making when planning new residential areas.

At the same time, however, it is also evident that regardless of the mathematical method used, forecasts of future housing demands, are subjected to certain constraints. This is partly due to the circumstance that even the most sophisticated models are unable to represent the complexity of reality to its full extent. On the other hand, quantitative model calculations always build on past observations and extrapolate the relationships and developments established for the past into the future under certain conditions. Especially when dealing with complex systems such as housing demand behavior, in which the uncertainty factor "human being" with its spatio-temporal changeable behaviour patterns plays a central role, one must be aware of the capabilities and boundaries inherent in the predictive power of mathematical models. At this point it should therefore be emphasised that the strength of the model presented in this paper lies not so much in forecasting but rather in simulating local housing demand potentials. Implementing the results of the model calculation one-to-one into the planning process is neither intended nor desirable. Rather, the results should serve as a foundation for discussing different development scenario from which a vision for the development of the future residential area can be derived. This also illustrates the main strengths of the model: increasing transparency and encouraging ideas.

6 REFERENCES

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