Beyond direct availability:
Housing vacancy chains explored

Abstract

In terms of housing, every single move is dependent on another households move, except when there is no previous resident –in case of an addition to the housing stock– or the previous resident does not need a new house –in case of emigration, or death, or a move towards an institution. In these four situations, a chain of moves that are all dependent on each other can be started. Housing vacancy chains give an insight into indirect availability of the housing market. However, to date, this method has not been used often. This research reconstructs all started housing vacancy chains in the Netherlands on a micro level, using register data from Statistics Netherlands. Results show that the type of house is related to age and life-course events: chains that start because of death or an institutional move generate more diverse types of houses further in the chain, while new construction generates more apartments. The results can be used in decisions on which types of houses to build until 2030, as the Dutch government has planned to build 100,000 houses annually.

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1 – Introduction

The current housing stock of the Netherlands, both, in terms of owned properties and (social) rental houses, does not seem to be in balance; first of all, there is an absolute shortage in houses (Ministerie van B.Z.K., n.d.). Second, there are more single-family houses in the housing stock than households with more than one person, (Statistics Netherlands, 2021a, 2021e) meaning that the stock in terms of efficiency and capacity is not fully used. A shortage of houses is problematic because if a household is not able to move due to a lack of suitable houses, they, in their turn, also do not leave a house for another household, which results in a decrease in turnover. This can be problematic, as there are fewer opportunities for the second household to find a suitable house.

Until 2030, the Netherlands has planned to build 100,000 houses annually to meet the expected demand (Rijksoverheid, 2021b). If a house is added to the stock, it has a direct effect, since it enables a household to move, without being dependent on someone else's move. There are, however, indirect effects on the demand as well: the move of a household towards a new constructed house facilitates another household to move to the vacant house that is left behind. A series of moves that are dependent- and indirectly follow up on each other, is called a "housing vacancy chain". Housing vacancy chains have the potential to gain insight into which houses become indirectly available as well.

So far, the few studies that have paid attention to housing vacancy chains, suggest that the characteristics of a housing vacancy chain – such as length of a chain, type of house, ownership of the house, and socioeconomic characteristics of a household – differ per type of new constructed house (Bratu et al., 2021; Turner, 2008; van Dam et al., 2010). For instance: a chain that starts with an expensive new built semi-detached house has the potential to provide housing for a more diverse audience further in the chain, whereas a new built social rental house just provides housing for lower-income households (Bratu et al., 2021). This is relevant since these results can be used to determine whether it makes more sense to build 1,000 apartments, rather than 1,000 detached houses to meet the demand that is indirectly generated further in the chain.

A new constructed house is the easiest example of starting a housing vacancy chain, as it is an addition to the housing stock and directly enables a household to move. There are, however, other ways of starting a housing vacancy chain: (life-course) events, such as death- or emigration of the previous resident(s) enable a start of a chain as well, since the former resident(s) will not occupy a new house. Some of the studies have, next to new construction put little attention to (e)migration (Bratu et al., 2021; van Dam et al., 2010; Turner, 2008) and death of the previous resident(s) (Lévy et al., 2017; Turner & Wessel, 2019). However, the influence of these events on the housing market has not been discussed thoroughly, although the significance of these other starting points on the direct availability of houses should not be overlooked. Previous research in the region Groningen-Assen of the Netherlands has shown that the majority of current owners of single-family houses are 65 years or older and as a single- or two-person household (Statistics Netherlands, 2022b), they do not need the full house anymore in terms of capacity and space. Additionally, The Netherlands is ageing (Statistics Netherlands, n.d.-b), and within 10 years 15% of the population reaches the average life expectancy of 86.39 years old. So, demographic events such as death or moves toward institutions, are likely to have a major influence on the balance of the housing stock in the upcoming years. Therefore, it is interesting to research the indirect effects on the housing market if households move into a house that belonged to someone who passed away. To rebalance the housing market, it is implied that it is not necessarily needed to build more large single-family houses, but that we have to build differently to stimulate households to move onward.

Whereas previous research on housing vacancy chains was often based on statistical methods to simulate chains (Lévy et al., 2017; Turner, 2008; Turner & Wessel, 2019), this

research is data-driven, based on register data from Statistics Netherlands. which allows for a full reconstruction of housing vacancy chains on a micro level. Hence, this data-driven research reconstructs all housing vacancy chains in the Netherlands that start because of death, emigration, moves to institutions, new construction, and transformation, to analyze the indirect availability that is generated.

This paper is divided into six sections. Section 2 briefly describes demographic trends in the Netherlands to emphasize the need for houses in quantitative terms. Secondly, the relation of migration to life-course events is discussed, to highlight the relevance of researching different housing types. A method to gain more insight in housing types, is reconstructing housing vacancy chains. The concept can, however, be hard to grasp. Therefore, section 3 starts with an example to clear the functioning of a housing vacancy chain, after which a theoretical explanation of the concept of housing vacancy chains is given. Section 3 ends with a review of previous research and states hypotheses that follow from the theory. The methodology section, section 4, discusses the chosen method for this research, the operationalization, assumptions, and biases. In section 5, the findings of the data analysis based on the hypotheses that are stated in section 3 are presented. Lastly, section 6 ends with a discussion and recommendations for further research.

2 – Quantitative and Qualitative need for houses

The need for houses can be approached from multiple perspectives. Although other factors, such as low mortgage interest, investors that buy up properties to let on (Rijksoverheid, 2021a), and a decrease in new construction due to the nitrogen crisis (NOS, 2019) have an impact on the housing market as well, this chapter focusses on the quantitative and the qualitative need for houses alone. First of all, there is the quantitative need for houses: the Netherlands is home to 17 million people and they need to live somewhere. Section 2.1 describes the population structure in the Netherlands in 2021 and how the full housing stock is divided over the population. Second, there is a more qualitative need, which translates to types of houses and if houses suit households, regarding their wishes. Section 2.2 dives deeper into the theory of life course events and to what extent internal mobility is related to both age and the type of houses in which households live.

2.1 – Housing needs concerning demographic trends

The current Dutch population exists out of 17 million people (Statistics Netherlands, 2022a). Based on the most recent projections, it is expected that the Dutch population will grow further, up to 19 million in 2036. This is caused by two main reasons: a positive migration rate, meaning that more people are entering the country than leaving, and an increasing life expectancy (Statistics Netherlands, 2021c). Especially the increasing life expectancy is a major contributor to population growth: for a 65-year-old male, it increased from 78.9 in 1956 to over 83 in 2020, which means that the population of elderly increases, leading to population growth (Statistics Netherlands, 2021d). Today, almost 20% of the Dutch population is 65 years or older whereof a quarter of that group is in the age group of 70–75-year old's (Statistics Netherlands, 2022a), (see figure 1).

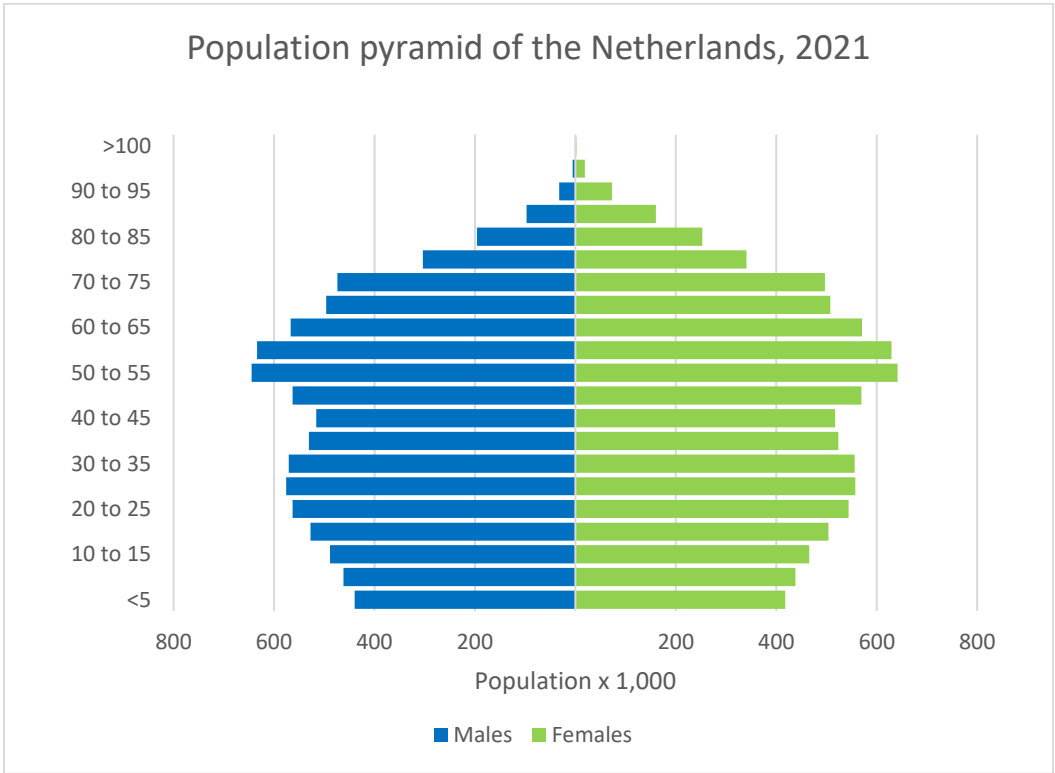

Figure 1. Population pyramid of the Netherlands, 2021

Source: Statistics Netherlands (2022a)

Another trend, that can be seen is that the number of single-households increased since 1947 from 5% of the population to 22% in 2017 (Statistics Netherlands, 2018). Whereas the household size was on average 3.54 persons in 1961, it was 2.14 perons at the beginning of 2021. The number of households has grown faster than the population (Statistics Netherlands, n.d.-a). This phenomenon, where the household size decreases while the population increases, results directly in a need for more houses. Furthermore, it is expected that the average household size will shrink even further up to 2.06 persons per household in 2070 (Statistics Netherlands, 2021b). While the average household size is projected to shrink, the Dutch population is expected to grow further, resulting in an expected growth of households. Statistics Netherlands expects that there will be more than 9 million households in 2038, which is an increase of 1 million (Statistics Netherlands, 2021b).

As discussed, the Dutch population is ageing, and at the same time, people older than 70 live more often alone compared to other age groups. As this age group increases, more elderly start to live alone and have therefore a major impact on the household size (Statistics Netherlands, n.d.-a). Besides, research from Statistic Netherlands (2022b), focusing on the region Groningen-Assen in the Netherlands, has shown that more than 40% of the 65 years and older live in either a semi-detached or a detached house. As shown in Figures 2 and 3, this age group has in general houses with a lot of square meters, a higher property value and are more often the owner of a house compared to younger age groups. Besides, people of 65-years and older live more often in smaller households: without children, or alone. Without considering individual values and simply thinking in terms of capacity, it is arguable that a relatively large group that does not necessarily need it (anymore) lives in the biggest and most expensive houses. Whether that can be considered as problematic or not, within 10 years, this 65+ age group reaches the age of at least 75 years. Additionally, 14% of the Dutch population is already 70 years or older and reaches or comes close to the expected average life expectancy of 86.39 within 10 years (Statistics Netherlands, 2021d). It is therefore likely that within 10 years the availability of larger single-family houses will increase due to population structure, caused by both moves towards institutions and mortality.

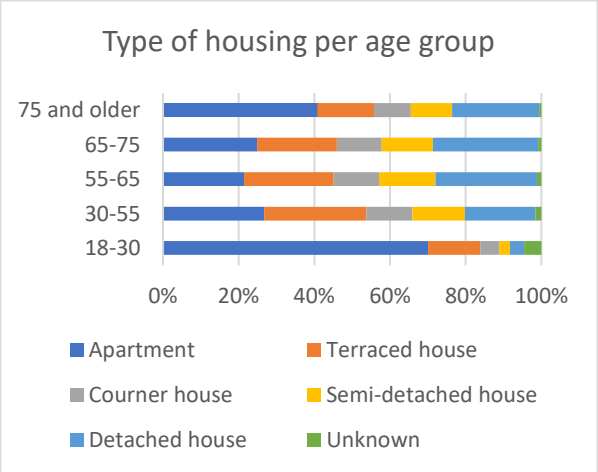

Figure 2. Type of housing per age group in region Groningen-Assen, the Netherlands.

Source: Statistics Netherlands (2022b)

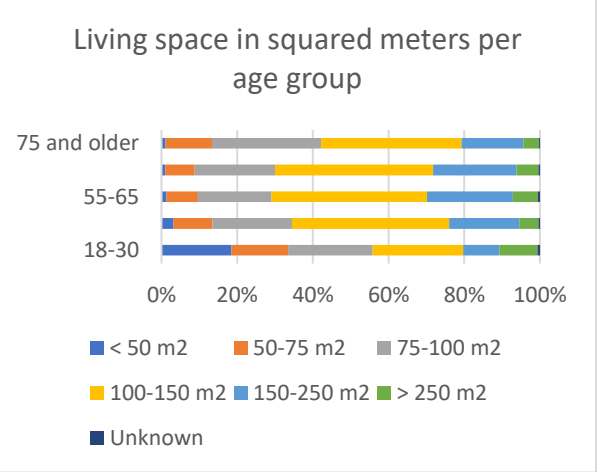

Figure 3. living space in squared meters per age group in region Groningen-Assen, the Netherlands.

Source: Statistics Netherlands (2022b)

With a housing stock of 8 million in 2021(Statistics Netherlands, 2021e), it is necessary to build more houses to accommodate all projected households that are expected in 2030. Although it seems like there is already a shortage of houses in the Netherlands, the housing stock consists of more than 5 million single-family properties, whereas the number of households with more than one person is 4,9 million. It suggests that there are currently enough

houses, but that the distribution of housing types is out of balance; a claim that is supported in the previous research of Statistic Netherlands to the region of Groningen-Assen (2022b).

The unbalance in the distribution of houses combined with a shrinking household size, makes it more urgent to gain in-depth knowledge of the housing market. It is significant to understand what happens indirectly on the housing market after a new household moves into a house that becomes available because of moves towards institutions or death of the previous resident. The Dutch government wants to build 100,000 new houses annually until 2030, the knowledge about what types of houses to invest in is vital to bringing the housing stock in balance.

2.2 – Qualitative housing needs: The relation to life course events

For multiple decades, there is consensus in the literature that people move to adapt to their changing life course trajectories. This has been suggested already in 1955 by Peter Rossi and can still be seen as a base in the current literature (Coulter & Scott, 2015; Geist & McManus, 2008). Migration is an age-structured phenomenon and it is possible to draw a line that shows the frequency of moves per age (Bernard et al., 2014). For the Netherlands, we see the following pattern in 2018 (see figure 4): young children under 5 move often because of family expansion (Kuyvenhoven et al., 2021), after which it decreases. At 18 years, the frequency of moves starts to increase steeply, which is caused by children who leave the parental home, because of (higher) education entry and exit, labor force entry, and partnership formation (Mulder & Hooimeijer, 2002). Then there are moves because of first childbearing, a change of job, or when children leave the house. A small bulb can be seen around 65 years when people move after retirement. After 75 people move often because they go to an institution (Bernard et al., 2014), as they develop health problems (Artamonova et al., 2020).

Hence, a change of residence is often triggered by life course events, such as family expansion, or starting a new job. These events take often place at the young adult age and may require significant changes in their lifestyle explaining the peak in that age period (Bernard et al., 2014; Willekens, 1999).

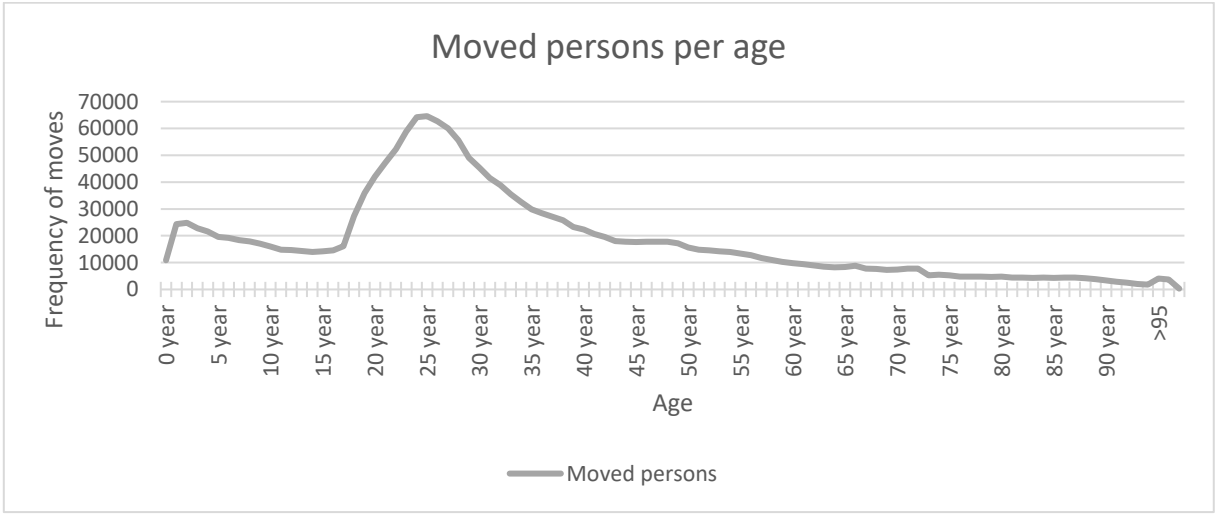

Figure 4. Frequency of moves per age in the Netherlands, 2018

Source: Statistics Netherlands (2022c)

Throughout their life, people experience events, such as starting education, migrating, entering the labor market, or marriage. The events can be decomposed into so-called life-course

trajectories. Life-course trajectories can be visualized as parallel lines that interact and run next to each other in a person's life. Within these trajectories, events, specific points in time that happen in a life course, can occur (Clark & Dieleman, 1996), see figure 5. Mulder and Hooimeijer (1999) stated that the parallel life course trajectory may lead to a discrepancy between the current housing situation and the preferred situation. For instance within the household and housing life course trajectories; a certain event, such as expecting a second child may occur, which could be a trigger to move if the housing situation does not give room for a second child (Mulder & Hooimeijer, 1999; Özüekren & van Kempen, 2002).

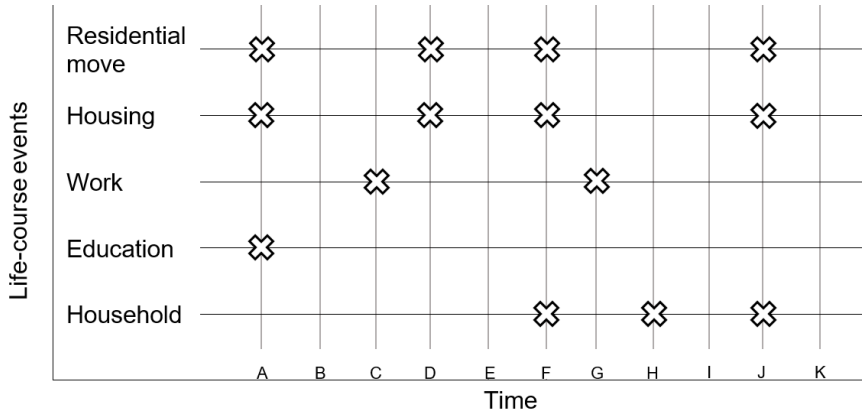

Figure 5. A hypothetical lifecourse of person X.

Source: Author

Family expansion is, as shown by recent research, a major trigger to relocate: 61% of children move at least once during childhood at a relatively young age of 4.8 years on average, often over a short distance (Kuyvenhoven et al., 2021). A move where a young child is involved implies that the house does not fit the demands of a growing family anymore and that therefore the event of family expansion, is a trigger to relocate towards a new house that fits their trajectory. During their lifespan, a household can live in a series of dwellings in a row, which is called a housing career. The housing career of a family is not necessarily stratified, although households start in general by moving into dwellings at the bottom of the market and subsequently moving to more desirable units in more desirable locations (Özüekren & van Kempen, 2002). It is therefore theoretically expected that during their life course, people move, in general, to more expensive houses, leaving a less expensive house behind. A method to test this theory is reconstructing housing vacancy chains.

3 – Housing vacancy chains

Housing vacancy chains can be insightful since they enable researchers to understand occupancy trends in the housing stock to get an insight into turnover in the housing market. Housing vacancy chains have, for example, been used before to research who gains from the new construction of houses (Turner, 2008). However, the concept of a housing vacancy chain can be hard to grab, as the subject is the house, rather than the household. But, in order to reconstruct the chain, you first need a move of a household, before finding the new subject. Besides, the method is not used often before. Therefore, section 3.1 will elaborate on the method with an example of a housing vacancy chain to explain and visualize the concept, after which it is explained theoretically. Section 3.2 discusses existing literature more in-depth, before we move on to the hypotheses in section 3.3.

3.1 – Definition of housing vacancy chains

The easiest way to explain what a housing vacancy chain is, is to give an example: Audrey currently lives in a *terraced house* (house B), but she has planned to move to a *new constructed semi-detached house* (house A). With Audrey's move to the new constructed house, her old house, house B, becomes vacant. Audrey's move offers an opportunity for Brian and his household, who are currently living in house C. Brian decides to move to house B and since Brian and his household moved, their old *apartment* becomes vacant as well. This provides an opportunity for Christina, who is also searching for a house.

A chain stops when it does not provide a vacant house anymore; Christina used to live together with Derek, however, she moved out because of marriage dissolution. Derek, her ex-husband, stays in house D, where they used to live together; which means that with Christina's move into the *apartment* no vacant house was left and the vacancy chain comes to an end at house C. The housing vacancy chain that started with Audrey's move and ended with Christina's move is shown in figure 6.

Next to new construction, a housing vacancy chain can also start if the previous owner does not have the need for a new house, which is in case of death, emigration, or a move towards an institution. These events can trigger a vacancy chain as well.

The chains in this research are followed from A, – the starting point on the left, – to C, the end of the chain on the right. However, a condition is that a person or the full household first has to move in the opposite direction, from the right to the left before a chain can move on. Lastly, the italic written housing types in this example can be changed for other housing types as well. During this paper, I will refer to this example to make sure that the results are interpreted in the right way.

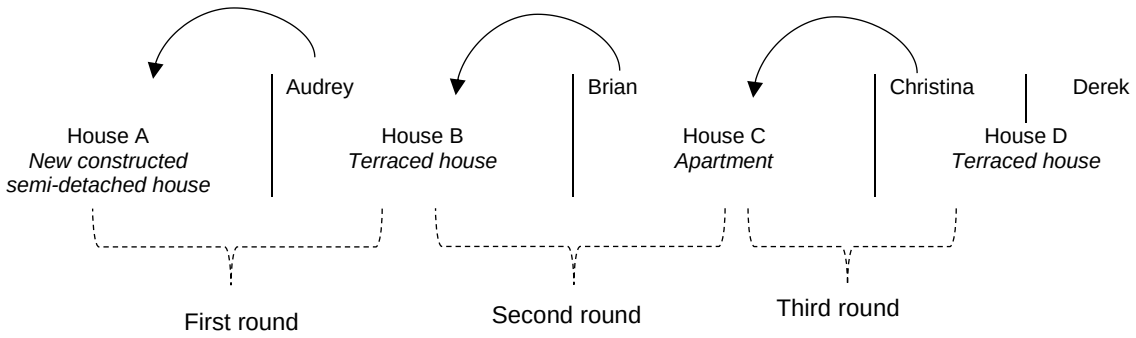

Figure 6. Visualization of a housing vacancy chain with italic housing types as an example.

Source: Author

In general, when a household moves out to another dwelling, their new house is empty. Brian could not have moved into house B if Audrey did not move to house A. So in most cases, relocation is dependent on either a move of the previous residents or the death of the previous resident(s). White (1971) was one of the first to suggest taking the perspective from the house, instead of the household. A house is seen as an "object" that does not change over time, while households do. According to White, houses are not consumed in the same way as other goods in "classical economics", since the lifespan of a house is in principle indefinite. White stated that a house fits certain demands of a household and if the house cannot meet these needs anymore, the household moves out and a new household moves in, while the house stays more or less the same. According to White, moves at the housing market take therefore place with the characteristics of a vacancy: as supply and demand are less important, price is not the dynamic element in the housing market (White, 1971). A second characteristic of a vacancy is

that the "mobility of several individuals is linked together: What happens to one individual at one point in time and space redounds to affect other individuals at other points in time and space" (Chase, 1991, p. 134). Other characteristics of a vacancy are that individuals from time to time need to or want to change from house; generally to a larger or improved house; that vacant houses are scarce and that most individuals already have houses, so they can leave a house behind (Chase, 1991).

Hence, a vacant house enables a household to move, which in its turn enables again another household to change address. Multiple houses in a row that become vacant because of the move of its residents to another house form a housing vacancy chain. It is possible to reconstruct these chains, by using microdata of the new residents of a house and their previous address. A household is solely used to identify their previous address and once the previous address has been identified, it is no longer needed to keep track of the household, since we again look at the previous house of the new residents; meaning that the housing vacancies are the key units rather than the households (Turner, 2008; Turner & Wessel, 2019).

One vacancy chain exists of multiple "rounds" where each move from the previous house to the new house is a round in the vacancy chain (see figure 6). The first round – or starting point – of a chain can only be a house where no one occupies the following house. This happens in three cases: either, the house is added to the housing stock, the house becomes available because the previous resident has died (van Dam et al., 2010; White, 1971), or the house becomes available because the former household emigrated (Turner & Wessel, 2019). Theoretically, a fourth starting point is the moving in of persons in an existing household, so when Brian would move in with Audrey. Then Brian's house would be a starting point of a new chain since he does not reside in a vacant house. This situation will, however, not be further discussed, because it is beyond the scope of this research.

A vacancy chain stops when a move is not resulting an empty house anymore. For instance: Young-adults who move out of their parental home because they go to college, or ex-partners that stay behind in case of marriage dissolution (van Dam et al., 2010), so where Derek stayed in house D. Important to understand is that the chain comes to a stop after Christine moved out. If Derek decides to move as well, after Christina left, his move is part of another chain, not related to the chain of which Christina was a part.

3.2 – Previous research on housing vacancy chains

Despite being quite limited, research on housing vacancy chains has been done in the past. The first known research on housing vacancy chains was applied by Firestone in 1949 (Lévy et al., 2017) and the main aim of this research was to gain a more in-depth insight into the Canadian housing stock (MacIntosh, 1951). This first research was, however, a highly time-consuming process, because the chains were manually reconstructed by visiting houses and interviewing residents about the former address (Lévy et al., 2017). To make reconstructing the chains less time-consuming, White (1971) was the first to suggest reconstructing chains with Markov projections instead. A Markov projection simulates the chains based on statistical housing opportunities and possibilities for a vacancy to make a transition (Turner, 2008; Turner & Wessel, 2019), based on one known move (Willekens, 1999). Markov projections have been used in the majority of research on housing vacancy chains (Turner, 2008; Turner & Wessel, 2019) since they have been introduced by White in 1971 (Lévy et al., 2017).

Based on Markov chain models, Turner (2008) analyzed housing vacancy chains in Stockholm to better understand the impact of who gains from newly constructed houses. Based on housing vacancy chains she concluded that the building of one new house provides a move for 3.7 households on average (Turner, 2008).

Although most previous studies use Markov projections, Lévy et al. (2017) had some concerns about using this method. To be able to use a Markov projection correctly, there are

some criteria, which are violated in research on housing vacancy chains. To use a Markov projection, characteristics between the study objects must be equal and stable. However, within the housing market, it is fully possible that two identical houses do not have the same types of households, that share the same residential mobility behaviours. Therefore, Lévy, et al., (2017) proposed another method, which takes both mobile and immobile households and characteristics of the housing stock, as well as sociodemographic characteristics of both mobile and stable households and chain effects into account. Although the proposed model (ibid) is designed to solve the potential shortcomings of a Markov chain, it is not fully recreating the chains but simulates them instead.

In line with the original idea of interviewing residents about their former addresses, it is also possible to reconstruct the chains based on register data. A drawback of this method is that it requires a complete database of all persons in a certain region, which could be problematic if registers are not that reliable. Register data of the Netherlands is however seen as high quality, as citizens must register events, such as relocations, births, marriage, and deaths (Prins, 2017), and is therefore seen as a reliable method to reconstruct housing vacancy chains. In 2010, van Dam et al. used register data to reconstruct housing vacancy chains in specific regions of the Netherlands. They found that in specific regions of the Netherlands, households that move into the new constructed houses, have a higher income and a Dutch background. However, as the move takes place further in the chain, both, the characteristics of the households and the spatial locations change, which is seen as a positive effect on segregation. Important to mention is that the outcomes differ per type of neighbourhood: new constructed houses have a small positive effect on segregation if the new house is placed in a full new constructed neighbourhood (van Dam et al., 2010).

Hence, the socioeconomic diversity of households changes as the chain becomes longer. Bratu, et al. (2021) recently published comparable research: they reconstructed housing chains based on Finnish register data, starting with new constructed houses. Similar to van Dam et al., (2010), they found evidence that new constructed houses in more expensive neighborhoods primarily accommodate wealthier households. The chain that got triggered by the moves to these new houses, however, shows that middle- and low-income neighborhoods are reached within two years. Bratu et al. (2021) concluded that despite new constructed houses being allocated to higher-income households, low-income households benefit from the new more-expensive houses as well.

Contrary to more expensive new constructed houses, they found that new constructed social houses, do not change the share of moves substantially. The research implies that building houses for higher-income households, might be more beneficial for stimulating turnover, than investments in lower-income, or first-time buyer households (Bratu et al., 2021). This is an outcome found by van Dam et al. (2010) as well. They found that new constructed houses hurt segregation when placed in a neighbourhood that "needs attention" (van Dam et al., 2010). In that case, the characteristics of a household do not change as the chain becomes longer.

Overall, the above-mentioned studies have similarities in terms of theme and underlying theories, they are, however, not fully comparable in terms of method. Some are based on statistical simulations (Lévy et al., 2017; Turner, 2008; Turner & Wessel, 2019), others are based on register data, but have another aim (Bratu et al., 2021; van Dam et al., 2010). What they do have in common is that all studies aim to study what is happening after a house becomes available for the market.

3.3 – Hypotheses

Despite previous research, several aspects of housing vacancy chains remain about which relatively little is known. This research aims to give first of all insight into the types and characteristics of houses that become directly available because of death, emigration, a move

towards an institution, new construction, and transformation, and second what this direct availability means for the indirect availability of houses that become available in the chain.

Whereas previous research focused on "starting a housing vacancy chain" without differentiating in a start because of death, emigration or new construction (Bratu et al., 2021; Lévy et al., 2017; Turner, 2008; Turner & Wessel, 2019; van Dam et al., 2010), this research compares the events of starting a housing vacancy chain as well, including a move towards an institution and transformed houses, existing buildings without a residential purpose that have been transformed to houses.

As mentioned in the section "quantitative and qualitative needs", people move during their life in general toward bigger and more expensive houses (Chase, 1991; Özüekren & van Kempen, 2002). It is therefore expected that the housing career can be seen through the housing vacancy chains in two ways: On the one hand, the event of death or a move towards an institution usually takes place at the end of the life course, after reaching the peak of the housing career. Emigration on the other hand, takes often place earlier in the life course (United Nations, 2020), and thus housing career, as well as we expect that a move towards a new constructed house takes place earlier in the life course. Therefore, we hypothesize first of all that a chain that starts with the event of death, or a move towards an institution, will be longer than a chain that starts with new construction, transformation, or emigration (*hypothesis 1*).

At the same time, it is known that elderly of 75 years and older often live in an apartment (see figure 2). It is therefore not sure whether an effect based on the event of death or a move towards an institution can be seen. Therefore, we focus on the housing career theory as well, hypothesizing that a chain that starts with a more expensive housing type, such as a (semi-) detached house, creates a longer chain, compared to a chain that starts with a less expensive housing type such as a terraced house or an apartment (*hypothesis 2*).

Last, we are interested in what type of houses become available after the chain has started. Research has shown that the elderly are more likely to move to institutionalized residential care when they develop health problems (Artamonova et al., 2020). Theoretically, they do so at the peak of their housing career, but at the same time, we know that 40% of people older than 75 already lives in an apartment (see figure 2). If it would be possible to recognize a housing career within the chain, we expect an increase in single-family houses and a decrease in apartments, if a chain starts with death or moves towards institutions of the previous owner (*Hypothesis 3a*). Second, we expect that a chain that starts with an addition to the housing market more often attracts younger households, and has therefore more effect on households that are at the beginning of their housing career. We, therefore, expect that a chain that starts with new construction or transformation has a decrease in single-family houses and an increase in apartments (*Hypothesis 3b*).

4 – Methodology

4.1 – Data collection

This research reconstructs housing vacancy chains on a micro level, by using register data from Statistics Netherlands. Statistics Netherlands developed a system (system of Social Statistical Datasets, SSD) in which administrative register data is standardized and can easily be linked as a result of assigned linkage keys. The SSD contains information on the complete Dutch population, households, jobs, dwellings, taxes etcetera (Bakker et al., 2014). This research uses data from the SSD, with the most important variables the address on 1 January 2018 and the address on 31 December 2018. Furthermore, it contains multiple variables regarding (1) the dwelling itself and (2) the household that lives at the address. Based on the SSD data it is possible to create a new dataset with help of R, a programming language for statistical

computing, which contains the information to research the housing chain on a micro level. SPSS is used to analyze the chains more in-depth.

4.2 – Operationalization

Despite that the data contains all the needed information, it is not possible to derive any information about flows and chains of migration. Besides, it is needed to create filters to extract chains based on the five starting points. (1) Death is based on the date of death. (2) Emigration is based on the date of departure. (3) Institutional moves are moves based on the type of household, whereas the type of household was not institutional on 1 January 2018 and was institutional on 31 December 2018. (4) New Construction, based on a dummy whether it is or is not new construction, and (5) Transformation, which are former buildings that did not use to have a residential purpose, but have been transformed into houses, also based on a dummy.

The dataset has four assumptions: (1) If a person lived at a certain address on 1 January 2018 and that same person is not linked to the same address on 31 December 2018, the person *has moved* in 2018. (2) If a person lived at a certain address on 1 January 2018 and that same person is linked to the same address on 31 December 2018, the person *has not moved* in 2018. (3) A person that is in the dataset on 1 January 2018 and is not on 31 December 2018, the person has either *died or emigrated*. (4) A person that is not in the dataset on 1 January 2018 and is on 31 December 2018, the person has either *been born or immigrated*.

To find the start of a chain, it is first of all needed to identify the start population. The start population is all houses where the former owner in the year 2018 died, emigrated or went to an institution plus all new constructed- and transformed houses. We will call them potential houses since they have all the potential to start a chain. The potential houses will be marked and then linked to the base data again to control whether the house is also left empty in 2018 or if other household members still live at the same address, in case of death, emigration, and a move toward an institution. After filtering for household members who stayed at the old house, we have extracted all available houses, where Audrey can move to.

Second, we recreate the first round by connecting all fully available houses to the base data again, which is Audrey's "move" towards a new address. It is now possible to extract Audrey's old address on 1 January 2018. We control again whether the former address is left empty and no one stayed behind, and if so, the former address is again the new start population for the next round, as this is Brian's new address.

The process of seeking the former address in the dataset, controlling whether the house is left empty, and identifying the previous resident(s), is repeated 10 times. It is important to understand that for each round we control for a change of address in 2018. We keep using the same dataset of the same year, expecting that a chain involves moves that all happen in 2018

4.3 – Biases and assumptions

A bias that we should take into account, is a bias that exists because of the chosen period of the dataset. It can be the case that house A becomes vacant at the end of the year 2018. For instance, when the resident moved towards an institution in November 2018 and family members have to prepare the house for selling. Then the house will not be for sale in 2018 and a new household will move in after January 2019. The same is for houses throughout the chain that remain uninhabited for a short time. It is beyond the scope of this research to extend the analysis to 2019.

Another bias is that we assume that a move towards an institution is seen as irreversible. In cases where the elderly move towards institutions, it is likely that they are not moving back. However, the filter for institutions is not based on the type of institution, but on the type of

household, because the data lacks this specific information. It could be the case that someone moved to an institution, the house became into custody and someone will move back in 2019.

Last, this research assumes that people do not move more than once a year, since we have two benchmark moments. It could, however, be the case that a household moves more than once. It is assumed that, when this is indeed the case, the move that is not taken into account, is for the household also seen as a temporary move, but it could be otherwise.

5 – Results

5.1 – Availability in round one

First of all, to gain more insight into direct availability, we present some general descriptive findings of chains that start with either death, emigration, moves towards institutions, new construction, or transformation, regardless of the housing type. In 2018, a total of 316.610 houses become potentially available for the market. Death and emigration are the biggest contributors to potentially starting a housing vacancy chain; in total 70% of all houses become potentially available because of death or emigration (figure 7).

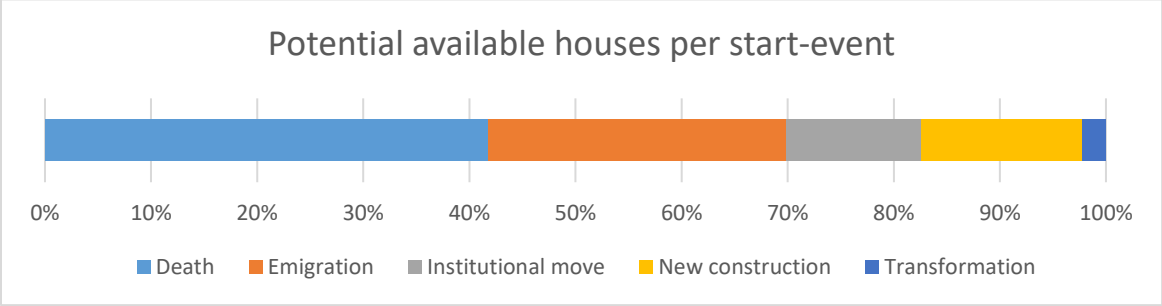

Figure 7. Potential available houses per start-event.

Source: SSD, author's calculations

In 45% of these 316.610 houses, the chain directly ends because household members of the person who experienced the start-event, such as widowers, stay in the same house and the house does not become vacant (see table 1, bottom row). Audrey is therefore not able to move to 45% of the houses where someone experienced the event of death, emigration, or a move towards an institution. 16% of the houses are not yet inhabited by new residents in 2018, so theoretically, Audrey could have moved here, but she did not, neither did someone else and the house remained empty. It is still vacant, so the houses will likely be inhabited in 2019, but we do not have data on this. Last, 10% is inhabited by immigrants who do not leave a house in the Netherlands behind, and therefore the chain comes directly to an end after round 1. So, to conclude, this means that out of the 316.610 houses that become available and have the potential to create a housing vacancy chain, 40% results in a chain that moves on for more than one round, which is Audreys move from B to A (see figure 6).

Table 1 shows how many of the potential starting points actually result in a chain that remains at least for one round and where house B is a house within the Netherlands. We find that death of the previous resident leads in 27% of the cases into a chain. Chains that start with a move to a house where someone emigrated from, are in 64% of the cases less than one round. That is for 33%, caused by people who do not emigrate along and remain in the house. Another reason for the end of a chain is that there is no house B, as in 31% of the cases house A is directly inhabited by immigrants, who do not leave a house in the Netherlands behind. Likewise, a move towards a transformed house is in 16% of the cases direct inhabited by

immigrants, which means that there is no house B. Hence, a house where someone emigrated or died enables the least chains.

Houses that become available because of a move towards an institution enable a chain in 38% of the cases. If people move towards institutions, there are less often people who stay behind, which enables the chain to move on. Since fewer people stay behind, the house is more often left empty and it is therefore likely that the house has to be prepared and sold by family members. This process takes some time and if someone moves to an institution in November, the house is not on the market and inhabited the same year. Therefore, the number of uninhabited is high, compared to the other starting events.

Last, new constructed houses trigger the most individual chains and enables therefore more households indirectly to move as well. New constructed or transformed houses are always inhabited, otherwise, they would not have been in the dataset. However, the number of new constructed houses in this dataset is lower compared to the official number of new constructed houses in the Netherlands in 2018, which is 66.585 (Statistics Netherlands). Not all new constructed houses are already inhabited in 2018 and therefore not taken into account. The dataset lacks this information, therefore the number of uninhabited houses in case of new construction and transformation remains zero. Likewise, some houses that have been marked as "new construction" were already inhabited in January 2018. Since it is not possible to extract the previous address with help of this dataset, those situations have not been taken into account either and are not seen as new construction, explaining the discrepancy between the official numbers of Statistics Netherlands and our 46,030 new constructed houses.

Tabel 1. (Not) triggering housing vacancy chains that remain for at least two rounds

	End of chain	Uninhabited	Triggers a chain that remains for at least two rounds	Total available houses that trigger a chain that remains for at least 2 rounds
Death	51%	22%	27%	36,300
Emigration	64%	12%	24%	21,580
Institutional move	36%	27%	38%	15,280
New construction	4%	0%	96%	46,030
Transformation	16%	0%	84%	6,010
Total	**45%**	**16%**	**40%**	**189,510**

Source: SSD, author's calculations

5.2 – Length of chains

First of all, we expected that it would be possible to compare chains in average length. However, it turned out that housing vacancy chains, regardless of the type of starting point, have an exponential decay, and that a chain can remain for round after round until they actually end (figure 8). If the decay is high, the end will come sooner and the chain is short, and if the decay is low, the chain will be longer.

Although the first round deviates a bit from the trend, the data shows that there is overall an exponential decay of $1 - (e^{-0.651})$, which means that with every new round after round 1, there in total a decay of 48% in available houses. For example, that means that if there are, regardless of the starting event, 1,000 houses available for Audrey, 520 houses are still in the chain after she moved. Brian has therefore 520 houses to "choose" from and if he moves, again 52% of the houses remain in the chain. Christina has on her turn 270 houses she can choose from. The chain that started with Audrey's move comes to an end with Christina's move, as Christina did not leave an empty house behind, since she divorced Derek. House D is therefore

part of the 48% of houses that do not become available, even though Christina moved from house D to house C.

The exponential decay has been calculated by noticing a trend that with each round the number of houses declined by more or less 50% (see table 2). Therefore we added an exponential trend line in excel and found that the numbers fitted the line very well, with an R2 >0.97. Theoretically, we expected a difference in total length between these start-events, because of housing careers (*hypothesis 1*): people tend to move in general towards bigger and more expensive houses, so since the event of death or a move towards an institution often takes place at the end of the life course and after the peak of their housing career we expected to see this difference in the length as well. We could not find evidence to support this hypothesis: A chain that starts because of a move towards an institution has indeed a slightly lower decay (46%) compared to transformation (50.2%), which means that it will take a bit longer to reach the final house in the chain. However, the differences are so small, that it is not that relevant. The fact that a chain that starts with the event of death has still 110 houses in the chain after 10 rounds, while a chain that starts with a move towards a transformed house has 10 left, is mainly caused because the total houses that become available because of death is higher, not because of the difference in length.

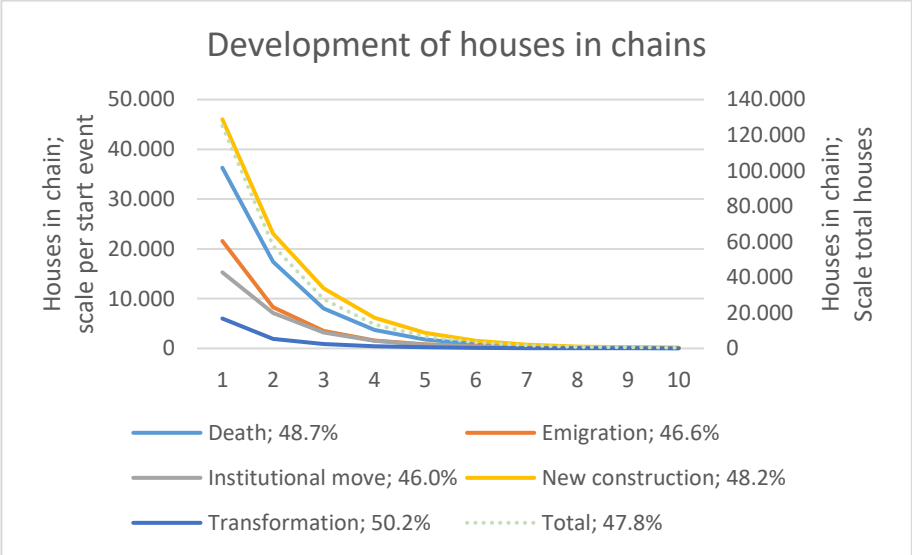

Figure 8. Development of houses in chains

Source: SSD, author's calculations

We also wanted to know how many houses are generated in the chain per start event, as it can give an insight how many rounds it takes, before reaching the availability of the first round again. Table 1 and figure 8 both show chains that remain for at least two rounds (so there is a house A and house B). However, we also know that chains that start with emigration and transformation both have a high number of immigrants whom direct move into an A house, but do not leave a house in the Netherlands behind. The first column of table 2 (p. 19) shows per event how many houses become fully available and inhabited. The second column shows how many available houses also have a house B in the Netherlands, which means that the chain moves on for at least two rounds.

Although it seemed like emigration generates 31,320 available houses in the first place, after controlling for immigrants, just 21,580 houses actually triggered a chain. Also transformed houses have a high number of immigrants moving in (see table 2). The total generated amount of houses that become available because of emigration and transformation is therefore lower than table 1 suggests. To gain more insight we, calculated the growth rate by taking the

cumulative total of all houses that become available and are generated in the chain over 10 rounds, and divided that number over the total available houses, including houses where immigrants started to live in round 1. A growth rate >1 is a decrease in total generated houses, =1 an equal amount of total generated houses and >1 an increase of total generated houses.

We found that all chains have a positive effect on the stock of houses and the housing stock does not decrease over time, although it takes multiple rounds to have at least an equal amount of available houses compared to round one. Chains that start with emigration or a transformed house have a low growth rate, compared to chains that start with death, a move towards an institution, or new construction. While chains that start with death, a move towards an institution or new construction almost double themselves in total availability, chains that start with emigration and transformation stay behind in overall availability, which is mainly caused by the high percentage of immigrants in round 1. It can be said that transformed houses and houses where someone emigrated from, have more often another target audience, than the houses that become available because of death, a move towards an institution or new construction.

5.3 – Housing types

Although housing vacancy chains differ slightly in length per starting point, it is theoretically expected that the housing type at the beginning of the chain has a higher influence on the length of a chain compared to the start events. *Hypothesis 2* stated that compared to a chain that starts with an apartment or terraced house, a chain that starts with a (semi-)detached house will be longer. In other words: if Audrey moves to a detached house, her move likely creates a longer chain, than when she moves to an apartment. We found that (semi-)detached houses have less decay in the chain, compared to corner houses, terraced houses, and apartments and are therefore longer. The overall exponential decay is 47.5% and we see that both detached and semi-detached houses have a lower decay rate than the total. Regardless of the starting event, a chain that starts with a (semi-)detached house has in general a longer chain compared to a terraced– or corner house or apartment (table 3). However, the differences are so small, that it is insignificant. The housing type that becomes available does not seems to be relevant for chain length.

Tabel 3. Decay per housing type

Type of house	Percentage decay per round*	Total houses at start of chain
Detached house	43.8%	8,590
Semi-detached house	46.6%	6,930
Corner house	48.1%	10,590
Terraced house	47.3%	22,430
Apartment	48.6%	61,580
Total	**47.5%**	**110,110**

Source: SSD, author's calculations

*R2 >0.94

Rounded to tens

Going deeper into the housing types, we combined the type of house and the event of starting a chain. We first analyzed which housing types become available because of the start events, so which housing type becomes available for Audrey, and why. The results show overall a similar distribution, despite in case of new construction and to a lesser extent transformation. Death, emigration and a move towards an institution have a high number of vacant apartments,

while new construction has a more diverse supply of housing types. Transformed houses are often apartments (see table 4).

Tabel 4. Distribution of available housing types in the first round, house A.

Available housing type / **Event**	Detached	Semi-detached	Corner	Terraced	Apartment	**Total**
Death	1,320	1,260	2,550	5,050	25,680	35,870
Emigration	940	690	1,420	3,850	14,390	21,280
Institution	460	530	1,080	2,200	10,940	15,200
New construction	6,040	4,640	6,020	12,690	16,560	45,950
Transformation	160	70	50	120	5,600	5,990
Total distribution	8,910	7,180	11,130	23,900	73,170	124,290

Source: SSD, author's calculations

Rounded to tens

Lastly, we wanted to know which housing types become available further in the chain that has been triggered by one of the start-events, to study whether we can recognize a housing career within the chains. We found major differences between the start events and the type of houses that indirectly become vacant in the chain. A chain that starts because of the death (figure 9) or a move towards an institution (figure 11) of the previous resident(s), generates in the first place mostly apartments (see table 4). Round 2 however, generates just over 50% available apartments, while the amount of other housing types increases. A chain that starts with the event of death or a move towards an institution decreases in apartments over time and increases in the other housing types (*hypothesis 3a*). Contrary, chains that start with new constructed houses (figure 12) have a more diverse distribution of housing types in the first place, however, there are more apartments generated during the chain (*hypothesis 3b*). Although we can find evidence for supporting the hypothesis in case of death, moves toward institutions, and new construction, the hypothesis does not hold for emigration and transformation (figure 10 & 13).

Together, these results provide important insights into housing vacancy chains and what happens indirectly in the housing market if someone dies, emigrates, moves towards an institution, or starts to live in a new constructed, or transformed house. The next chapter moves on to discuss the results together with recommendations for further research.

Tabel 2. Total houses that are generated (per round)

Event of start	Round 1 including immigrants	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6	Round 7	Roun d 8	Round 9	Round 10	Cumulative total round 1-10	Growth rate over 10 rounds
Death	37,500	36,300	17,420	8,050	3,720	1,810	860	460	250	150	110	69,110	1.843
Emigration	31,320	21,580	8,290	3,500	1,610	820	420	230	140	100	90	36,780	1.175
Institutional move	15,950	15,280	7,130	3,220	1,520	750	390	210	120	90	80	28,770	1.805
New construction	47,890	46,030	23,060	12,080	6,150	3,130	1,530	770	390	240	130	93,520	1.953
Transformation	7,140	6,010	1,930	880	450	220	90	50	30	20	10	9,670	1.354
Total	**139,780**	**125,210**	**57,820**	**27,730**	**13,440**	**6,730**	**3,290**	**1,720**	**930**	**600**	**410**	**237,860**	**1.702**

Source: SSD, author's calculations
Rounded to tens

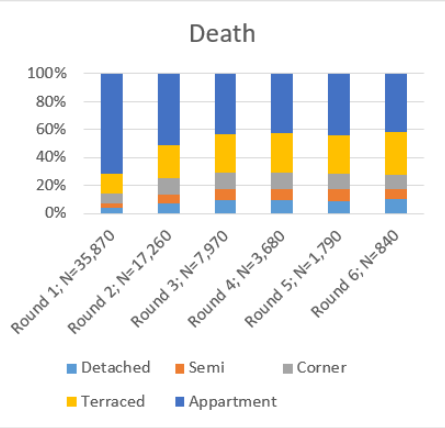

Figure 9. Housing types that become available in a chain that started with death of the previous resident(s)

Source: SSD, author's calculations

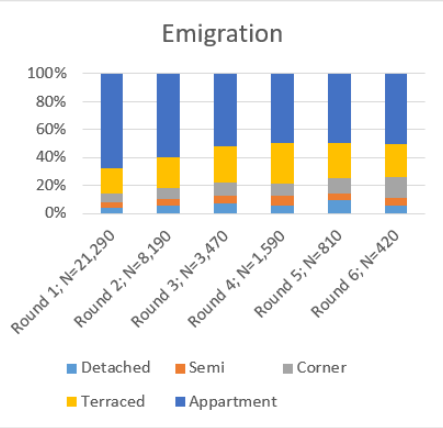

Figure 10. Housing types that become available in a chain that started with emigration of the previous resident(s)

Source: SSD, author's calculations

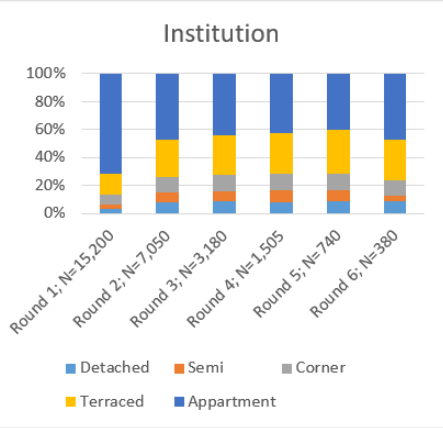

Figure 11 Housing types that become available in a chain that started with a move towards an institution of the previous resident(s)

Source: SSD, author's calculations

Figure 12. Housing types that become available in a chain that started with a move towards a new constructed house

Source: SSD, author's calculations

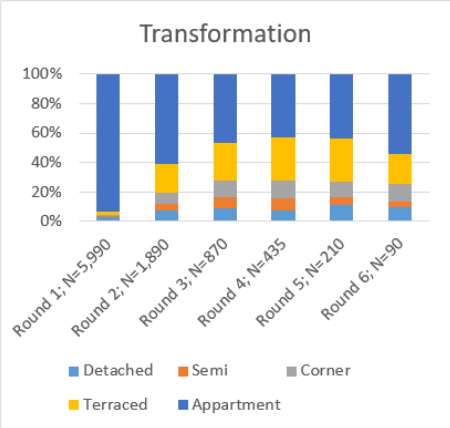

Figure 13. Housing types that become available in a chain that started with a move towards a transformed house

Source: SSD, author's calculations

6 – Conclusion and discussion

Previous research already showed that new constructed houses indirect enable other households to move as well (Turner, 2008) and that less wealthy people also benefit from new constructed more expensive housing types, although they have not moved there themselves (Bratu et al., 2021; van Dam et al., 2010). The indirect effects of housing vacancy chains that are generated because the previous owner does not need an up following house, has however not been researched before. Besides, it was not quantified before how long housing vacancy chains can be. In this study, we researched both housing vacancy chains that start because the previous resident does not need an up following house, which is in case of death or emigration or a move to an institution, and housing vacancy chains that start with the addition of a house to the stock, in case of new construction and transformation. We used register data from Statistics Netherlands which contained all registered inhabitants of the Netherlands in 2018 and their addresses on 1 January and 31 December. We first reconstructed all individual housing vacancy chains on a micro level and analyzed them on a macro level.

We provided a more in-depth insight into the concept of housing vacancy chains and how (life-course) events that have the potential to start a housing vacancy chain indirectly enable other households to move as well. The findings show first of all, that most chains that go on for more than 1 round, are generated through new construction, transformation, and moves towards institutions. Second, the results indicate that transformed houses or houses where the household emigrated have a different target group, as these houses have a high percentage of inhabitance by immigrants: 31 and 16 percent respectively.

Another interesting finding was that housing vacancy chains cannot be measured in length or amount of rounds, since the decay is exponential. If the decay is low, more houses remain in the chain, which will result in a longer chain with more indirect availability. Contrary to our expectations, the start-events show a similar pattern with insignificant differences. A possible explanation for this outcome is that a high percentage of houses available because of death or a move towards an institution, are still inhabited. The decay will likely be lower if the analysis is extended to the year 2019. Besides, for this analysis, we used all houses that enable a chain for at least two rounds, so without houses where immigrants started to live. Therefore, we also calculated how many houses are generated in total and compared the total to the houses that became direct available because of the start events. We found that chains that start because of emigration and transformation have a low growth rate, while chains that start because of new construction, death and move to institutions have a high growth rate.

Besides the differences between start events, we also paid attention to the housing type. Our analysis shows, contrary to our expectations, insignificant differences between the types of houses that become available, regardless of the start event. We expected to see some differences, as for most people, it is not possible to buy a large, expensive, detached house as a first house. They move upward during their lives and might be able to live in a detached house one day (Chase, 1991; Özüekren & van Kempen, 2002). Hence, it is likely that the new household that starts to live in a detached house does not leave a small apartment behind, but a larger housing type as well, which goes on for more rounds, compared to an apartment.

Therefore, the final analysis combined the housing types with the start events. The results regarding death and institutional moves do support the idea that it is possible to recognize a housing career, by studying the housing vacancy chain, rather than households. As shown in the theoretical framework, previous research, focusing on the region Groningen-Assen in the Netherlands, shows that the far majority of people elder than 75, live in an apartment (see figure 2). This specific group is also the first to move into an institution or experience the event of death. It is therefore not surprising that these starting points directly contribute to the stock of apartments. At the same time, death and a move towards institution

lead further in the chain to the availability of fewer apartments and more single-family houses. According to the housing career theory people move in general towards bigger houses, until the moment they move into apartments. That leads to the logic that the house before an institution is in general a bigger housing type, with a high property value, a theory that we indeed can recognize in the data. On the other hand, a chain that starts with new construction generates overall more apartments. It is, therefore, reasonable to think that new constructed houses in general facilitate more households that are at the beginning of their housing career, who are more likely to leave an apartment behind. Although it is not possible to control how many houses will become available in the future because of events such as death, emigration and moves towards institutions, the outcomes are valuable in decision making in what to build.

Despite the promising outcomes, a note of caution should be made: A limitation of the dataset is that it did not contain information about another year than 2018. As we have mentioned, quite a high percentage of houses remain uninhabited in 2018 and it is likely that those houses have been inhabited in 2019, and enable a chain as well. It could be that, once the analysis would be extended to 2019 or even 2020, other results come up. However, since all chains show a quite similar pattern, it is expected that the pattern will stay more or less the same, but with a slightly higher or lower decay. Furthermore, the data lack, as mentioned before, moves that happen between the reference dates, resulting in an incomplete image as well.

Another note to make is that in some cases, multiple events were happening. For instance, within one household, one person died and the partner emigrated. In that case, it is not possible to say which event started a chain, since that is often based on personal decisions. We cannot tell whether someone emigrated because someone wanted to emigrate, or because the partner died and therefore it did not make sense to stay in the Netherlands. Therefore, we decided to take the first case in line, which is a random choice. Although these situations are not likely to have significant influence on the outcomes, it is good to mention, especially if the study would be repeated.

There are several options for further research: first of all, it would be valuable to expand the analysis to 2019 and 2020, to gain a more complete image of chains that start with death, emigration, and a move towards an institution of the previous resident(s), as in those cases the number of uninhabited was high. A second option would be to do the same research on a regional level, as it is valuable for local regions to know what happens in their specific context. In that case, the research should not only take immigrants and emigrants into account but also regional settlers and leavers.

Including information on actual characteristics of households would be a last interesting addition; then it becomes, for instance, possible to research the percentage of house owners and renters further in the chain, or the median income, age, and type of households. It would then be possible to study more in-depth which households gain from a house that becomes available because of one of the start events, and what would be a good investment to serve a specific audience. Although it is not possible to control which houses become available because of death, emigration, or a move towards an institution, we potentially could have some influence on the step before. If we keep in mind that the current population of people 65 years and older largely resides in a (semi)detached house and we also know that a (semi) detached house creates in general longer chains, it could be possible to stimulate this specific group to move to other houses and steer on more availability of (semi) detached houses, to create longer chains.

We should, however, bear in mind that simply focusing on longer chains is not the solution to the current shortage in the housing market. At the end of every chain is a starter: a household that starts their housing career and searches for their own residence. A municipality that decides to invest in 500 starter-houses, immediately helps those 500 starters, whereas a municipality that invests in 500 houses with gardens helps 500 households, but has lost 48% of houses in the second round. Although stimulating longer chains might increase the probability

to find a suitable house overall, it is not a direct solution for the growing group of starters, something we should keep in mind.

Overall, reconstructing housing vacancy chains by the use of register data seems to be a reliable method to research which houses become indirectly available for the market. Further research is needed to answer the question of which households gain from specific situations.

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