

USING DATA VISUALIZATION TO UNDERSTAND HOMEBUYER PREFERENCES

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Abstract

The industry has changed significantly, and its characteristics depend on macroeconomic processes and the needs of Caucasian consumers. As this data availability has grown, tools enable 'showing' homebuyer behaviors, and understanding scheme markets has become essential. Data visualization greatly differs from report-style work, which can be highly generalized and not provide the detailed information necessary to draw conclusions and make decisions from the raw data set down and analyzed by data visualization specialists using heat-map displays, scattergrams, and even predictive modeling charts. It allows developers, real estate agents, and policymakers to analyze data, recognize trends, and make decisions about the market's future. This paper aims to evaluate the application of data visualization in the homebuyer segmentation aspect with specific regard to how this tool can assist in identifying behavioral patterns to improve strategic objectives. Such topics would include using visuals in demand clusters, location preference and type of housing, and predictive analytics for market trends. Real-world examples, including heat maps for uncovering the optimal market niche and self-learning models for predicting prices, explain how these tools work in real estate. However, this research also sheds light on new trends in real-time data integration and sustainability, specifically in visualizing new issues in the housing market sector. While more and more explicit analyses predominate in the decision-making process due to the development of methodologies and technologies for data analysis and visualization, the ability to read graphics will remain significant because of the specific features of the industry. When strategies are based on the understanding of consumer needs, decision-making by the stakeholders can be improved, and they can, hence, better manage the future evolutions of the market.

Keywords; *Data Visualization, Homebuyer Preferences, Housing Market, Real Estate, Predictive Analytics, Heatmaps, Buyer Behavior, Market Trends, Housing Preferences, Visualization Tools.*

Introduction

The journey of homebuying in the United States, especially, is complex owing to a number of influences. Other factors are influential to buyers and included in the economic situation, such as income levels, affordable mortgage prices, and other market factors, such as the costs of housing. At the same time, demographic factors, as well as cultural changes, have considerable influence on the actions of consumers. For example, millennials may have different needs than baby boomers due to either city or rural living and the desire to have a large family home as compared to a millennial who might not be able to afford it. Apart from these broad factors, micro-level factors such as the types of homes people prefer, their preferred locations, and the kind of facilities they desire also play a crucial role in influencing buying behaviors. This factor calls for detailed consideration. Many standard market reports contain essential economic information that is missing the level of detail required to analyze the specifics of homebuyer preferences. They pool together general patterns, including changes in the price level or quantities of sales, and therefore do not account for the causes of these changes. For example, a report may show increasing home prices in a particular area and fail to point out whether they are a result of better schools, better access to workplaces,

or any other location attractiveness. Like with any static document, dynamic market information and shifting buyer needs, such as the need for more house offices due to the COVID-19 pandemic, cannot be addressed. This limitation poses a problem in decision-making for real estate investors, developers, real estate agents, policymakers, and consumers.

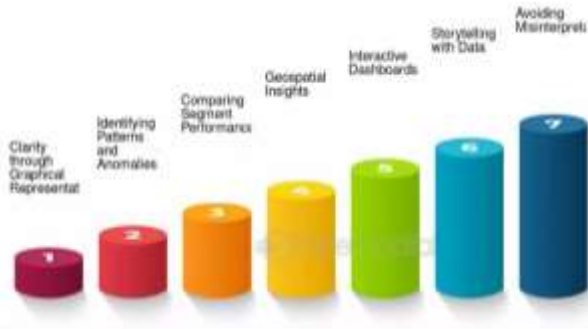


Figure 1: The Power of Data Visualization

In this regard, data visualization is revealed to be an enabling technology. It comprises the conversion of information and data into graphic formats, which makes complex data sets, such as diagrams, charts, heat maps, and scatter plots, easier to understand. Moreover, these tools assist not only in the simplification of vast amounts of data into easily consumable visuals but also help reveal patterns and relationships that might be hard to find when dealing with raw data. In housing markets, data visualization plays a key role in the interpretation of buyer behavior, trend analysis, and subsequent business decision-making, which gets more important in a competitive field.

Another essential benefit of data visualization is that users can reveal patterns and connections from a large set of data. Sources of fragmented data in the US housing market include the US Census Bureau, Zillow, and the National Association of Realtors. These datasets include price fluctuations and loan rate preferences, demographics, and regional demand differences. However, because of the lack of robust analytical tools, most of these data points inundate the stakeholders, thereby underutilizing these factors. Visualization tools fit the gap that enables the acting on this information to be done effectively. For instance, heat mapping can represent regions of high and low interest from the market for one's offering. For their part, the line graphs can show variations in relation to the mortgage rates and the level of buyers that can indicate changes in the economic environment on purchases. Another is scatter plots, where it is possible to view one variable against another; for instance, the income levels against the housing types will clearly show the main customers' choices. Such tools not only facilitate comprehension of information but also facilitate more efficient interaction of stakeholders by making the latter easily comprehensible.

Data visualization is not restricted to explaining past and present statistics, but it also analyzes future market trends. The use of visualization techniques enhances decision-making through the use of predictive analytics that provides stakeholders with anticipation of future buyers' movements and general market trends. For example, during the pandemic, graph arrangements showed the growing interest of customers in suburban houses with separate working zones. These trends, for instance, have the potential to influence supply and demand dynamics or the choice of the target market by real estate players or altering a marketing theme. In addition, the use of data visualization makes business intelligence more accessible to all. Previously, analyzing high-level housing data meant using certain analytical skills or knowledge that represented a limitation for practitioners. Nowadays, visualization helps to spread data, and it is accessible

to a broad spectrum of people, from policymakers who negotiate housing programs to average consumers. This brings about informed decisions, another factor that promotes and ensures the interaction of different personalities in any given project or organization.

These tools are of enormous significance as the housing market goes digital and relies on data analysis tools. They also enable the examination of complex top-level data and assist real estate personnel in recognizing consumer patterns in a condition that is frequently unpredictable. This paper focuses on the importance of data visualization in analyzing homebuyer preferences by segment in the United States and how it can revolutionize the real estate sector. The goal of visualizing data is to provide a view into the underlying patterns to help stakeholders mesh their strategy with the dynamic nature of the housing market.

The Role of Data Visualization in Analyzing Homebuyer Trends

Introduction to Data Visualization in Homebuying

Today, virtually no homebuying trend analysis can be complete without the use of data visualization. It allows those involved in the Real estate business, such as developers, agents, and policymakers, to gain valuable insights from big data sources. Using examples of more data from the National Association of Realtors (NAR) and Zillow, heatmaps, scatter plots, and line graphs make it easy for the general public to comprehend the data collected. These tools incorporate patterns, correlation, and causation into visual form to enable the stakeholders to detect and forecast the trends of buyer preferences to enhance the decision-making process.

Identifying Patterns in Buyer Behavior

It is worth noting that data visualization has made a valuable contribution by finding the types of homebuyers. For instance, heat maps help draw an illustration of housing demand with the areas of high interest indicated in the visualization (Grant, 2018). When it comes to property searches, aggregating data from Zillow can help create a heatmap of the markets. The hotter states and regions where buyer activity tends to spike and the cooler areas with lower sales performance. These insights may be especially useful to developers who are looking for new investment opportunities and to agents who are meanwhile searching for new ways and approaches to attract consumers. Likewise, scatter plots show trends between the variables, such as income brackets and types of homes required, and thus, the ability to reach out to distinct buyers.

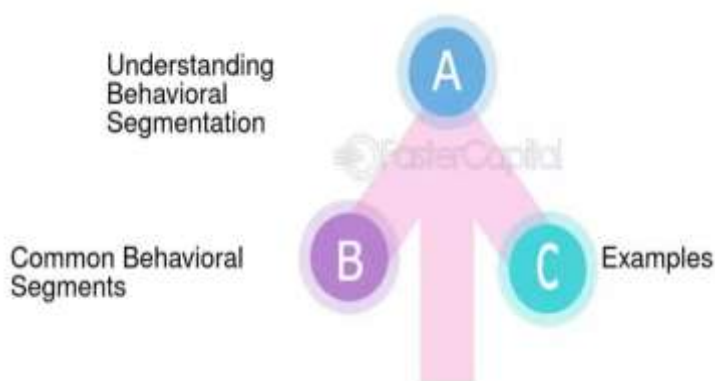


Figure 2: Identifying Customer Buying Patterns and Behaviors

For instance, the NAR "2023 Home Buyer and Seller Generational Trends Report" shows how generation demands particular attributes for homes. While millennials prefer an affordable house near their workplace, baby boomers would rather have houses situated in suburban areas with spacious floor areas. The opinion level can be easily compared using these graphical presentations, which facilitates the stakeholders' alignment with the consumers' expectations (Walker et al., 2008). Lacking such visualization techniques, finding such connections between the data would prove to be much more difficult.

Monitoring Market Dynamics

It is equally important for those working on changes in housing markets over time to use visualization tools. That is, types of line graphs include time series, for instance, in the case of property prices, mortgages, or changes in regional demand. In this article, these variables are arranged against time so that real estate workers can look at past trends and expect future changes. In the reports produced by Zillow on the state of the housing market, line graphs have proven useful in showing how, for instance, the rise in interest rates deters buyers. These visualizations will, in return, enable the key stakeholders to gain knowledge and insights into the happenings in the consumer markets as well as the volatility involved.

Another live example is the role of visualization in purchasing during the pandemic when homeowners started looking for houses with more space for telecommuting. Heat mapping of search activity and time series data on home sizes allowed stakeholders to better position themselves to cater to the new needs of remote workers. Whenever there is a change in buyer behavior, preferably caused by some outside forces such as an economic downturn or a health crisis, these tools come in handy.

Predicting Future Trends

A confluence of predictive analytics with the best data visualization tools makes for an extremely valuable tool with which to forecast the homebuying environment. Examples of descriptive static tools include line graphs and scatter plots, where we can develop future trends given past occurrences. For instance, using Zillow's models, the number and distribution of properties are forecasted using demographic factors and the general economic outlook of the property market segment. These visualizations help in getting to know where and when to launch new projects to avoid risk and gain the most benefits.



Figure 3: Real estate market analysis

Graphical productions of demand and forecast trends have also been so helpful in the planning of urban cities. (Hernandez et al., 2014) For example, a two-dimensional figure showing the correlation between projected population increase and the housing base may show policymakers that housing deficits may exist in the future and remedial action can be initiated. In addition to this, such tools are essential in

the formulation of the operational strategy over the long run while offering short-term gains, such as how current stock levels correlate to the expected demand by customers.

Enhancing Accessibility and Decision-Making

Candidates claim that data visualization makes complex information more accessible for those who are not involved in technical processes, which helps them to become a part of the decision-making. Historical data come in the form of structured datasets, and for most stakeholders who may not have technical prowess, trying to make a decision based on these structured datasets may be impossible. An example Gap that is filled by visualization is the fact that visualization relays information to the audience in a way that the audience first finds natural to understand. For instance, an easy bar graph showing the generational preferences of housing can bring important information regarding market segmentation in a matter of seconds. Furthermore, another advantage that can cause visualization to be well implemented in an industry is that it fosters cooperation among industry players (Kandel et al., 2012). All classes, starting from developers, agents, and policymakers, can access shared dashboards and interactive tools for strategic planning based on market trends. Because visualization makes data timelier and easily usable, there is a more efficient and informed real estate industry.

Enhancing Decision Making



Figure 4: Enhancing Decision Making

In the ever-evolving and information-intensive housing market, data analysis involves presentation plays a crucial role in analyzing, comparing, and forecasting home buying trends. Charts like heat maps, scatter plots, and line graphs turn the raw data into the companies' valuable findings that help measure market shifts and buyers' preferences, together with anticipation of future trends. This paper has revealed that with increased dynamism in the real estate industry, visualization will be key to decision-making and survival.

Visual Analysis of Homebuyer Trends Using Real-World Data

This knowledge is crucial to helping organizations, including real estate agencies, government institutions, and policymakers, as well as anyone else involved in the sale of homes. Commodity variables like price responsiveness, urban-to-suburban mobility, and mortgage interest rates involuntarily determine market parameters. These trends, included in a number of analytical tools such as scatter plots and line charts as well as double axis charts, are helpful in understanding buyer activity and buyer preferences, which assist in making key decisions.

Price Sensitivity and Budget Constraints

Different economic conditions and changes in mortgage costs and rates have rendered price elasticity one of the most influential determinants for home acquisition. Due to the increasing inflation and interest rates, the issue of affordability has taken center stage among buyers. Pricing trends for first-time homeowners also shifted by early 2023; while previous years would have netted out to afford higher price brackets, 60% of buyers focused just around \$300k-\$500k (U.S. Census Bureau, 2023). This transformation best demonstrates how budget determines housing preference and market dynamics.

Techniques such as the scatter plot are useful in establishing the correlation between interest rates and home prices. Through the help of a scatter plot of price ranges as the vertical axis and mortgage rates as the horizontal axis, this will be able to show the changes in the price sensitivity based on the economic changes over time. For instance, an increase in interest rates normally lowers the maximum acceptable price of homes for most consumers and can slow them down. These visuals provide cleaner and more digestible sets of data discrete than written reports and allow stakeholders to react positively or negatively to affordability. Key decision makers and analysts in this industry can use them to create solutions towards the affordability factor as a constraint through policies that include offering incentives to buyers and changes in interest rates.

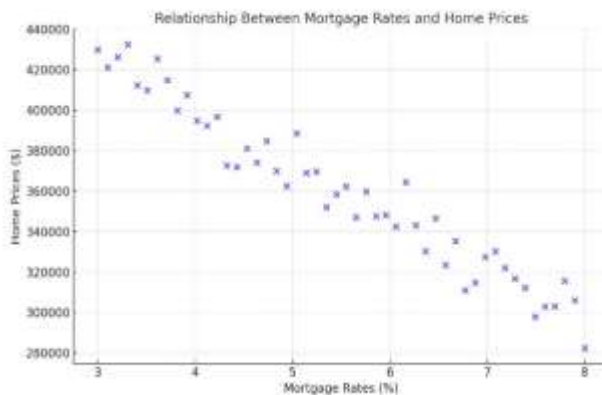


Figure 5: An example of a scatter plot illustrating the relationship between mortgage rates and home prices

Urban vs. Suburban Shifts

A clear choice has been made between urban and suburban living, changing dramatically in recent years primarily due to the COVID-19 pandemic. A process of movement from crowded urban environments to suburban or countryside zones was observed due to the demand for larger living spaces, lower prices, and a higher level of living. The U.S. Census Bureau estimates the suburban population to have recorded a 12% growth between the years 2020 and 2023.

Line charts play a significant role in identifying the changes in urban and suburban demand over time. The several categories in the visualization, when based on the buyer activity between metro areas and their suburbs, also capture the mobility caused by factors ranging from the pandemic. For instance, results from New York and some of its nearby suburbs present a picture of a dying urban market as more and more people buy in suburban territories (Hammett & Hammett, 2007). These changes also raise questions about how work-from-home policies and changes in lifestyle shaped the demand for housing. Families and professionals desired suburban areas with more space within the homes they rented and outdoor facilities that cities could not provide. Such patterns of migration not only profoundly affected the demand for

housing stock but also affected real estate, which occurred both in the cities and the suburbs. While markets in urban areas became saturated with property prices either stagnating or faltering, suburban markets faced an intensified competition structure; consequently, the prices for properties began to rise. Such a dual tendency reveals the necessity of examining changes in buyer behavior with the help of comparative visualization tools in the course of real estate agencies' and developers' work.

Influence of Interest Rates on Buyer Activity

The interest rates on mortgages, therefore, occupy a very sensitive role in the exercise, and they are normally the main determinants of capacity to finance the purchase and maintain homes. For instance, the interest rate that increased in 2022 by the Federal Reserve affected a dramatic decline in buyer activity. From one year to another, the average mortgage rate went from almost 3% to almost 6%. Thus, it is seen that the purchasing power of many potential homeowners decreased (Terrazas, 2014). This trend proves that monetary policy is directly affecting the housing markets. A dual-axis graph is very efficient as it shows the inverse correlation between mortgage rates and buyer activity. Overlaying interest rate trends with mortgage application data is used in the following graphs as an adequate representation of the decline in demand with increased rates. It is seen that such visual aids are not only used to demonstrate the existing trends of the past but also to predict future changes in buyer behavior. For instance, in situations where the rate is increased, there will be a new demand for smaller or cheaper homes as people cut down their expenditure due to increased rates on construction financing.



Figure 6: The Effect of Interest Rates on Consumer Spending

Borrowers' specific rates of interest payment also influence sellers in markets where the cost of living is high due to interest rate changes. Interestingly, higher rates pose a significant problem to the real estate market because many sellers cannot let go of attractive mortgage-linked rates obtained during low rates' reigns. In turn, this decrease in housing stock only makes affordability more challenging and muddies the waters of the entire situation. Qualitative trends can also be presented to the management or stakeholders in a bar chart or line graphs. This will help management reduce the time needed to develop responsive strategies on matters that have close relations between rate, supply, and demand.

The application of actual data and visualization tools and the availability of such homebuyer trends are significant for market analysis and transactions. Among the important factors that affect the demand for housing, the level of price sensitivity, mobility between urban and metropolitan areas, and changes in interest rates are fully or partially significant (Duca et al., 2023). Global data maps, scatter plots, line charts, and two-wire graphs turn data sets into great tools in business, making it easier for stakeholders to predict changes and make the right decisions. Since the economic and social conditions of a nation will remain dynamic in the future, the use of data visualization will never become irrelevant in helping the housing market find its footing and chart a healthy growth path.

Key Homebuyer Preferences in the U.S. Market

With the focus on home prices, it is indispensable to analyze homebuyer preferences, which will be useful for real estate agents, developers, or policymakers aiming to provide new homes for the peculiar housing market of the United States of America. Demographic and economic segmentation also influence preferences in the area, type, shape, and size of the house (Goodman & Thibodeau, 1998). These preferences are not merely whimsical proclivities; rather, they are reactions to the existential cultural and societal tendencies that define markets' initiatives and city planning. This section digs into chosen factors influencing homebuyers' decisions in the United States, accompanied by data visualization that aids in decision-making and forecasting.

1. Location Preferences

Hommetro says, 'Location is still the primary driver for home purchases, and people are interested in homes that are near their offices, have good school systems, are safe, and are fun'. That is why the National Association of Realtors found that 62% of homebuyers consider a good neighborhood to be essential, while only 38% value proximity to work. Several of these preferences can be seen in various areas where nearness to certain facilities greatly affects the housing market, with prices following suit. For instance, the southern part of San Francisco, such as the South Bay, has, over the recent past, seen most of its locations reporting high prices due to the proximity of such places to technology belts. Locations such as Silicon Valley present employment relationships that exist between place and employment (Carnoy et al., 1997). Employees have a strong concern for the proximity of their workplaces, thus creating high-demand density areas. Likewise, in suburban areas, measures including distance from parks, quality schools, and other recreational facilities, among other factors, dominate the rest. For example, parents with young kids may prefer to live closer to green spaces rather than commercial zones.

Using figures like heat maps helps to acquire invaluable information about location-dependent preferences. Heat mapping gives real estate practitioners the chance to identify the demand level by matching variables like proximity to schools or parks to the prices of homes. To reinforce this assessment, scatter plots fill in this tableau by featuring the interdependence of home prices and distance to amenities. For instance, in South Bay, one can see property prices due to concentrations in demand, such as access to technology offices. Thus, these tools help real estate agents and urban planners make decisions that will appeal to buyers and their tastes.

2. Housing Type and Size Preferences

This paper also identifies demographic factors such as age, income level, and family size as factors that affect the decision of homebuyers regarding housing types and size. They are willing to take small homes, particularly condominiums or townhomes, especially in urban areas, due to the increasing number of millennial homeowners. On the other hand, baby boomers have a preference for single-family homes with more space in suburban or rural areas, in view of their stage of life and normally higher income.

New numbers from the U.S. Census Bureau indicate that there are striking differences in how different generations view housing. Nearly half of the millennials stated their desired home type is condos or townhomes, mostly due to cost and location to city facilities. For instance, only 22% of baby boomers have expressed a preference for that particular size of house; most of them desire big houses that can accommodate other family members or can be used as a recreation area (Robison et al., 2014). These trends indicate reasons as to why housing has to be formed in a way that will respond to the needs of the different segments of people. Such generational preferences can be visualized using bar charts or, segmented graphs,

and so on. An organized bar chart used to compare the housing preferences of the two generations, for example, shows the extent to which the millennials are inclined toward the purchase of condos rather than the baby boomer's preference for suburban homes. The example of the charts mentioned above helps developers make better decisions in designing related housing projects that meet demand in targeted segments.

3. Trends in Home Size and Layout

Modifications in lifestyles and economic development have altered trends in home size and designs in the recent past. The pandemic has especially influenced the change, as people have started to look for houses with separate rooms for working from home and studying. According to Zillow, in 2022, there is a 24% uptick for homes with home offices compared to the rate before the pandemic, highlighting how flexible and versatile spaces have become essential.

Remote work is another reason that has been forcing buyers to adopt flexible open-concept layouts that maximize the use of space. For instance, the combined kitchen din, dining hall, and living room are now famous since they are flexible to accommodate family and work-from-home scenarios. Due to the fact that people want to feel as comfortable as possible in their homes or flats, new elements of architecture have been developed, and buying interest in them increased, including patios and gardens. Such trends can be most easily explained and depicted using time series line graphs. These graphs show the evolution of preferences since 2019 based on the increase in searches related to home offices. For instance, when comparing the number of searches for homes with offices from one month to the other, one can easily identify that such searches were high during the end of March, April, and May and then leveled off as the world adjusted to the new normal. Such insights can help real estate professionals better understand future demand and change their supply accordingly.



Figure 7: A time series line graph presenting the trends in homebuyer preferences by demographic from 2018 to 2022.

4. Regional Variations in Preferences

Variation by city or state illustrates the extent of variation across the serviced area of the United States as far as the needs and perceptions of homebuyers are concerned (Varady & Raffel, 1995). Large state sections, including the cities of New York and Chicago, have buyers in their youth who are pulled toward city life and earning potential, while large tracts of land together with the suburban and rural areas are more attractive to families who are attracted by space and affordable prices. All these variations depict broader

and more general economic and cultural factors that influence housing markets on local scales. For instance, people's ability to move from urban areas and work remotely during the pandemic showed that people are increasingly moving out to suburban areas. Main living areas also provided free spacious houses, less population density, and closer contact with countryside areas, which made suburbs more appealing to families and people who work from home. However, the growth of property markets declined in urban areas because property prices were relatively high, and the space was limited. Nonetheless, post-pandemic changes in urban living standards, such as the availability of cheaper houses and better infrastructure to accommodate residents, are gradually relating to urban areas (Guaralda et al., 2020). Such patterns and regional differentiation can be well illustrated by scatter plots and graphs constructed from two axes. A graphical representation of this case is the scatter plot of the property prices in the urban and suburban regions against the buyer activities to show how preferences have changed over the period. Likewise, the plot of migration rates, parallel with the home price change map, gives insights into the demand for the particular region. These visualizations allow the stakeholders to discover new opportunities and manage strategies according to regional requirements.

5. Implications for Real Estate Stakeholders

Perception and mapping of homebuyer preference present important implications for all stakeholders in the real estate industry (Prochorskaite et al., 2016). These findings can benefit developers by enabling them to create housing solutions that meet buyers' needs and preferences, for instance, developing high-rise flats in the concrete jungle of peri-urban areas or building large houses in sprawling peri-urban areas. It means that real estate agents can apply data visualization to discover the most popular locations and focus on market promotion. These insights can also help policymakers because efforts toward urban planning can be synchronized with developing trends in housing. For instance, heat mapping features on demand for certain facilities, and bar graphs depicting demographic trends generally offer a full view of the market. This approach ensures that plenty of strategies are not expressly founded on grouped data but are also convex to buyer segments and regions. Accordingly, through applying visualization tools, stakeholders can address the critical issues of the housing market with more accuracy and flexibility.



Figure 8: Strategies for securing stakeholders

American home buyers' preferences vary due to demographic, economic, cultural, and traditional factors (Levy et al., 2008). These preferences range from the location and type of housing stock to size and spatial organization, and they inform the approaches of practitioners in the real estate and urbanism domains. Information display is an important activity that assists in understanding these trends with clarity and the explicit information required to facilitate decision-making. In this fast-growing housing industry, market forecasting will always be the key determinant for success among players.

Case Studies on Visualization-Driven Insights in Homebuyer Behavior

In such a dynamic housing market, insights derived from visualization provide a much-needed guide on what to look out for. This section highlights two case studies: the application of a heat map to determine high-demand housing markets and other techniques used in modeling the price. These examples show how state-of-the-art data analysis tools help a firm's stakeholders understand the nature of the market and consumer trends.

Case Study 1: Heatmaps in Identifying Hot Markets

Heat maps are now widespread in real estate indicators as density displays that give an impression of hot spots. A study done by Realtor.com in 2022 showed that this tool helps spot the growth markets in housing. Based on the particular patterns of online property searches and price changes, the study noted a rise in demand in cities like Austin, Phoenix, Boise, and others alike during and after the COVID-19 pandemic. This city became fashionable when people worldwide decided to look for cheaper accommodation with ample space and a connection to nature. The heatmaps developed in the study revealed a density of the interest quantity of users in properties, with areas of high interest present as "hot spots." For example, some cities like Austin suddenly became crowded with workers in the technology field because the field is quickly growing, and their housing prices are still considerably lower than those of major cities such as San Francisco (Shaw, 2020). Like in Boise, many residents relocated to the area because of lower living costs, housing, and a less strict pace of life. These visualizations helped developers gain important details regarding areas where new pres-selling projects are expected to complement demand growth.

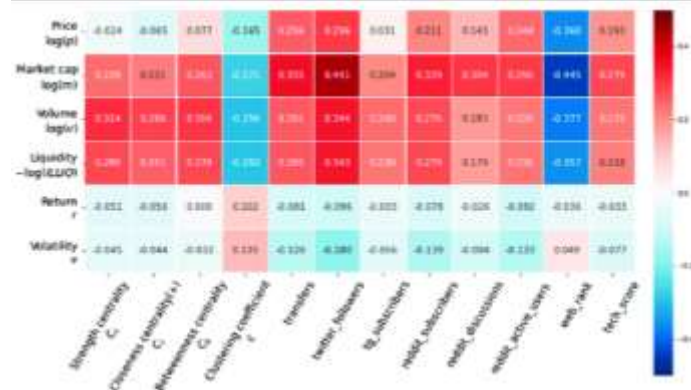


Figure 9: Correlation heat map between the market indicators and the market embeddedness and control variables

Heat maps also showed buyers' individual-level areas of interest within those cities. For instance, places near parks, schools, or newly established infrastructure displayed high-interest levels. There was a sharp rise in searches in areas that recently enjoyed better transport networks or near recreational amenities in Phoenix. This brought about a refined understanding by property developers and those who planned urban growth to provide housing in a manner that caught up with the buyers in these areas, thus helping to make better investments in these zones with high growth potential. Policymakers also benefited from these insights, in which heat maps were used to determine which regions to focus on in infrastructural development since they experienced high population density (Jia & Zhang, 2021). For instance, the city widened other elaborate public transport networks in Austin to suit the growing need for suburban houses.

Because heatmaps helped to paint a picture of regional trends, those involved were handed a way to tackle existing change and possible change in the future, thus making sure that short-term and long-term planning were covered.

Case Study 2: Predictive Models for Price Trends

Present-day approaches to strategic analysis have been enriched by predictive analytics demonstrated via machine learning. Algorithms in the real estate industry have come to play a proactive role in modeling future market trends (Stillebroer, 2021). The company spearheading the housing data analysis industry, Zillow, utilizes predictive line graphs to present valuable data on property price fluctuations. These models relatively amalgamate past sales data, regional and local economic parameters, and consumer behavior indices to help predict future prices with high precision. For instance, Zillow's predictive models helped assess the trends of the prices during the COVID-19 situation. As the buyers shifted to the suburbs and countryside, the models predicted that prices in these areas would rise and those that would only briefly level off or fall in cities. It was envisaged that places such as Chicago would decline occupancy levels due to people's desire and ability to obtain bigger, cheaper homes than apartments in outlying areas. On the other hand, prices were appreciated in all suburbs surrounding Chicago to indicate higher buyers' interest.

The following are predictive line graphs used by Zillow to illustrate these trends, with the help of which stakeholders may predict future price changes. These graphs coincide with the buyers because they give a clear impression of when to buy the property at the right price. The buyers can, for example, use the details to estimate likely durations, hence frequent buying to counter fluctuations. For example, a line graph like a predictive line graph, whose line rises steeply for suburban home prices, could compel developers to construct homes in such areas to benefit from high demand.



Figure 10: Evaluating Predictive Models in Multi-Product Price Forecasting

In addition to price, predictive models also indicate larger market trends to developers and policymakers. Zillow has also used its models to find promising future growth cities for housing, namely Charlotte and Nashville, because of their accelerating population and economic growth (Fields & Vergerio, 2022). These predictions also help stakeholders when it comes to resource planning. It becomes easier to manage these resources, with most channeling them towards areas with the most growth potential. Besides, this approach eliminates the dangers of putting capital into other risky ventures while at the same time guaranteeing adequate stock of houses in these areas.

Predictive models also have another advantage since they can include other factors from outside, like an increase in interest rates or any other disturbances in the economy. For example, when the Federal Reserve began raising rates in 2022, Zillow's models depicted the negative correlation between mortgage rates and buyers. The models also forecast a downtrend in purchasing power, forcing developers to look

for ways and means of either offering price incentives or targeting market segments that they feel are within their reach. Such valuable perceptions eliminated market fluctuations, allowing for maintaining the appropriate balance between supply and demand. However, it should be noted that there are several drawbacks to such predictive models. Many of them stand or fall by the quality and amount of input data fed into them. The Zillow models do well, but changes such as economic shockers or policy shifts bring variability. However, as machine learning algorithms are constantly developed, their reliability increases over time, making them valuable tools in real estate analytics. This new way of data presentation can significantly impact real estate. One advantage that heat maps offer is that they give a clear view of areas with high demand to help developers and policymakers target the right areas (Bush & Bale, 2019). While predictive models deal with the market's future price changes and prospects, they help stakeholders make their own decisions. Altogether, the tools suggest focusing on visualization-generated insights to manage the specifics of the housing market and satisfy the customers' emerging needs.

Future Trends in Data Visualization for Real Estate

Advances in Real-Time Data Integration

Incorporating real-time data in business, especially in the real estate sector, is redesigning the decision-making process. Special dynamic dashboards that enable the getting of the actual data from several sources at once allow stakeholders an increased degree of market vision. These tools help real estate developers, agents, and policymakers obtain real-time updated housing data that is more efficient than the previous types of published reports that get outdated in the shortest time possible. Advanced dynamic dashboards, which are GIS-based, give filtered details about the housing business, availability, prices, and consumer behavior (Rabiei-Dastjerdi et al., 2021). For example, different applications of GIS can identify growth areas in terms of demand and input, such as median income or rates of employment. This real-time integration also helps in quick strategy formulation because stakeholders can adapt to changes within the market very quickly.

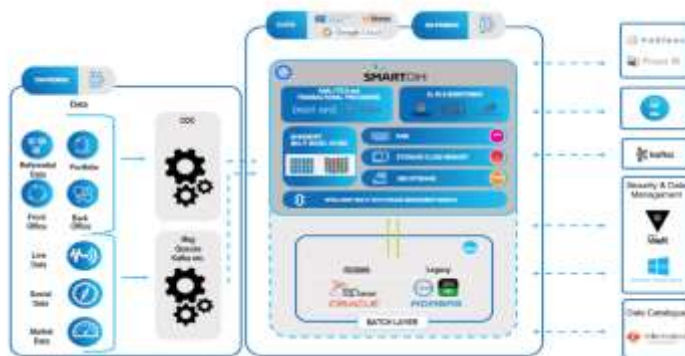


Figure 11: Using Real Time Data Integration for Better Real-Estate Business Outcomes

This is complemented by the take-up of cloud computing and data governance frameworks that also help increase the availability of real-time information. In today's world, solutions such as Tableau and Power BI allow real estate professionals to bring the data and represent it through interactive and creative interfaces instead of organizing standalone data silos (Milligan, 2019). For example, a developer working on a new housing project can display zoning laws, changes in demography, and new infrastructure on an

interactive map. These tools also offer the flexibility important for timely response to unforeseen events, including buyer behavior changes during economic crises or epidemics. Furthermore, the explainability of real-time data visualization and interpretation reduces risk tolerance. Trends can be tracked more dynamically so stakeholders can expect a market plunge or a housing surplus problem in some regions rather than constantly reacting to market problems. This capability shows that real-time data integration is now a critical weapon in the kinetics tool kit to gain a competitive advantage in a rapidly stratifying industry.

Predictive Analytics for Market Shifts

Big data, through machine learning and predictive analytics, is revolutionizing how stakeholders forecast market and buyer behaviors. Using daily and monthly statistics along with backward research, predictive models allow stakeholders to recognize regularities and predict current market tendencies with stunning precision. Another good application of machine learning is in predicting buyer preferences. Calculative tools like Zillow Zestimate include large amounts of transactions, real estate employment, and consumer behavior to predict the price and demand of homes (Qureshi et al., 2022) This approach can help stakeholders have the vision needed to make the right decisions in their business based on data. For instance, a machine learning-driven line graph could help developers estimate the projected prices of a particular, which will help them decide whether or not to invest by monitoring the trajectory over a certain period.



Figure 12: Benefits of Predictive Analytics in Real Estate

Lifestyle analysis is one of the most important areas of predictive analytics application in the context of the post-pandemic reality. The effect of the COVID-19 pandemic changed the demand for houses and apartments, and nowadays, homebuyers pay attention to the availability of a separate workspace. Predictive models employ scatter plots and dual-axis graphs to signal such transitional preferences. For example, relation statistics like the concurrency of remote work and uptake of suburban real estate make it easy for stakeholders to see prospects of unexplored regions.

It is also very useful during periods of economic volatility to make predictions. Such simulations give real estate professionals a better understanding of how consumers will react to interest or inflation rate changes. For instance, in a situation where there are high mortgage rates, the forecasts made by a model may be that there would be a high demand for small houses. Such understanding helps developers and agents to adjust their actions to fit the reality of the marketplace. The interesting intersection for further development of predictive analytics is its coupling with visualization platforms. With machine learning and data visualizations overlay, stakeholders can drill deeper and play through hypotheticals, such as how

changes in economic or policy factors will affect housing markets (Mihai et al., 2022). This capability improves decision-making and helps create a more direct attitude toward the market presence.

Sustainability-Focused Visual Data

As sustainability, especially climate change, transforms into one of the primary world challenges, the real estate industry has started using data visualization to enhance environmental goals (Allam, et al., 2022). Sustainability-themed visualizations enable stakeholders to acquire knowledge of environmentally friendly trends, enable development projects to align with consumer needs and preferences and support viable legislation for outstanding environmentally sustainable living standards. Some of the most prominent areas that involve ray-traced sustainability-focused visualization are in the demonstration of energy savings and property environmental stewardship. Important tools such as carbon footprint calculators and diagrams of energy use give valuable information on long-term savings and environmental gains that can be received by purchasing homes with a green label. For instance, a bar chart depicting the energy used by normal houses against those with solar power brings such incentives.

Heat mapping is especially desirable in the context of identifying the regions with heightened requirements for environment-friendly housing. These tools superimpose the environmental factors, including air quality or availability of green space, on the regional housing information. For example, to build houses with such utilities as water harvesting systems and energy-saving gadgets, the developers can identify, from a heat map, the areas where consumers are most conscious of environmental issues (Kim et al., 2021). Similarly, these visualizations may also be useful to policymakers in determining where best to invest in green infrastructure for areas with high demand: parks, renewable energy grids, and so on.

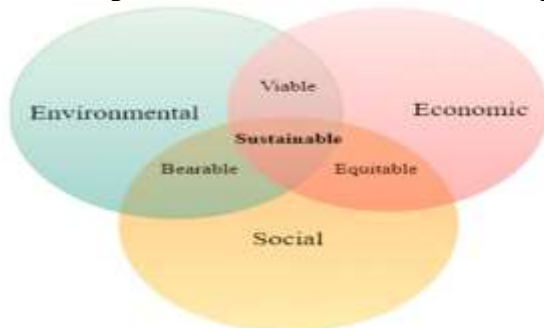


Figure 13: Example of Assessment of the Sustainability of a Real Estate Project

Predictive analytics are also used in sustainability visualization to determine how regulations or environmental indicators will affect housing markets in the future. For instance, the forecast of the following figures, such as those illustrating the adoption rates of energy-efficient building codes, can be utilized by developers in developing compliance strategies while at the same time marketing their projects as environmentally sustainable. Further, illustrating how it will be financially feasible in terms of less energy consumption may help convince developers and buyers to adopt effective green procedures. However, sustainability-focused visualization has significant barriers, such as poor data comparability and a lack of unified reporting guidelines (Liang et al., 2021). Still, as disclosures for ESG reporting continue to spread, sustainability data should become more accessible and accurate as well. This evolution will improve the capacity of real estate stakeholders to factor in green in their processes.

Conclusion

In the present context of the United States, data visualization is a critical input in evaluating buyers within the overall housing market. It converts the raw data into useful and functional information that can help those involved in the real estate business, be they developers, agents, policymakers, or even consumers, effectively manage their operations in the ever-growing real estate business worldwide. Specific multimedia like heatmaps, scatter plots, and line graphs make it easier for stakeholders to read the underlying patterns in the buying behaviors. For instance, heat maps provide precise information on the extent of high demand, which is useful when looking for hot markets for development by developers and agents. Scatter plots give a richer picture of relationships like the income level and types of housing that are common to help properly match what the buyers want. For instance, while line graphs are useful in observing factors such as the prices and mortgage rates and shifts in regional demand, their ability to provide a temporal perspective is essential for purposeful planning.

Data visualization is also mentioned to have a transformational impact on understanding generational and demographic differentiation. It very differentiates how millennials seek small and inexpensive urban homes from what baby boomers crave for large suburban houses. Such observations that can be depicted in simple bar charts or segmented graphs are highly relevant to the market segmentation process and, hence, the key to effective marketing strategies. Moreover, changes in demand for the organization of residential spaces and shifts in demand caused by factors such as the COVID-19 pandemic highlight the need for visualization. Home office time series and open-concept designs visually illustrate how visual analytics change to match society's objectives. Besides, data visualization helps predict current market trends and helps stakeholders understand future market conditions. Buyer behavior-predicting models and data visualization prepare organizations for the next steps, new opportunities, or threats. For example, predictive line graphs showing a relationship between population growth and housing requirements assist the user, in this case, the urban planner or developer, in properly distributing capital.

As sustainability becomes a critical driver for real estate, data visualization proves to be its major advantage. Housing-oriented carbon footprint calculators, energy use diagrams, and heatmaps with sustainability emphasis present the environmental and financial incentives for green housing. Apart from educating buyers, these visualizations help policymakers and developers make their efforts relevant to the environmental perspective. However, the sustainability analytics integrated with the model will be increasingly significant as environmental awareness increases. Real-time data integration is one more step in the evolution of data visualization. Geographically enabled applications can deliver real-time market information to stakeholders through dynamic dashboards, which also form the foundation for dynamic executive dashboards. Such tools are very useful in a technologically enhanced field rife with constant changes within short periods and, thus, the need for quick turnaround insights. However, data dissimilarities and the absence of common reporting formats remain problematic. Mitigating these problems by improving the quality of data and standardizing formats will only increase the effectiveness of visualizations. Data visualization, as used in this research, refers to an analysis tool and an approach to solving housing market-related problems. Decision support tools align with these attributes because they make data easily understandable, conspicuous, and useful for everyone. As technological advancement continues to increase, visualization and other predictive and real-time analysis tools will become crucial elements in strategic planning in the real estate industry as stakeholders seek to be more responsive to the continuously changing needs of homebuyers.

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