Data Analysis and Visualization of Factors Influencing Builder Performance: A Study on Turnover, Ratings, and Service Offerings in Madurai's Construction Industry

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**Abstract**: A house is essential for enhancing people’s well-being, ensuring health, and fostering development. For children, the presence of a secure home is critical for growth and stability. A quality home not only benefits individuals but contributes significantly to national development. The right to a home, alongside basic needs such as food and clothing, is fundamental. N. Periyamayan’s 2019 survey on homelessness in Madurai, Tamil Nadu, highlighted the growing issue of shelter deprivation. The study, covering 53 individuals, found that seven were homeless, and 24 lost their homes due to catastrophes such as fires and evictions. A critical concern identified was the difficulty in accessing affordable builders or contractors, making home construction a major challenge for many. This problem includes issues related to the cost of construction, quality of work, and the time involved in completing a home. A key technical factor is the cost-effectiveness and efficiency of building materials, such as tiles, which play a significant role in housing affordability and quality. Additionally, builders’ skills in selecting and installing durable, cost-efficient materials like tiles directly influence the overall cost and completion time of a project. This growing homelessness issue underscores the need for affordable housing solutions that address both construction costs and the practical challenges of creating sustainable homes. The study revealed that those outside civil society were more receptive to assistance in securing housing, emphasizing the need for targeted interventions to support vulnerable populations in accessing safe, quality homes.

**Keywords:** Builder performance, Construction industry, Service offerings, Turnover analysis,Performance ratings

Data visualization,Statistical modeling, Data transformation, Data integration, Data wrangling,

# Introduction

Exploratory Data Analysis (EDA) is a critical technique in data science that involves analyzing datasets to summarize their main characteristics, often with visual methods, before applying any machine learning models. It helps in identifying patterns, spotting anomalies, testing hypotheses, and checking assumptions, which is essential for making data-driven decisions [1]. In the context of housing and contractor selection, EDA plays a crucial role in understanding the factors that contribute to homelessness and how reliable and affordable contractors can alleviate these issues. By analyzing data on contractor costs, services, and performance, EDA enables a clearer view of the challenges people face when trying to build homes within their budget [2]. N. Periyamayan's 2019 study on homelessness in Madurai, Tamil Nadu, reveals that many individuals are unable to find trustworthy contractors, leading to increased homelessness. This research underscores the importance of using data to help people make informed decisions about contractor selection to avoid overpaying and ensure high-quality work [3]. The study involved gathering data on 53 participants and contractors, revealing key insights into pricing and services. Furthermore, a unique dataset of contractors in Madurai was created, which includes contact details, pricing, and years in business—information not readily available on search engines. This dataset serves as a valuable resource for people looking to hire reliable contractors. The next steps of the research include conducting a literature survey on contractor selection and housing affordability, followed by detailing the methodology for data collection and analysis. The implementation phase will focus on creating accessible platforms for sharing the data, while the results and analysis will highlight the relationships between contractor performance and housing outcomes.

# Related Works

The literature on contractor selection, housing affordability, and the use of Exploratory Data Analysis (EDA) techniques in residential construction has grown significantly from 2020 to 2024. Various studies have investigated how data-driven approaches can optimize contractor selection, which is a crucial element in affordable housing development. S. Ghosh et al. [3] emphasized the role of EDA in analyzing data to understand the dynamics of affordable housing development and its impact on cost efficiency. They noted how the right contractor selection could significantly reduce project costs and improve housing quality in urban settings. Similarly, Kumar and Yadav [4] explored the use of machine learning alongside EDA to predict housing prices and analyze the role of contractors in affordable housing projects. The study provided insights into how contractors' pricing strategies and performance evaluation can be optimized using data analysis techniques.

Gupta and Shah [5] focused on contractor performance evaluation, using EDA methods to assess and compare the performance of contractors based on several criteria like timeliness, cost-effectiveness, and quality of work. Their research concluded that contractor selection plays a pivotal role in determining the success of residential projects, particularly when it comes to managing project budgets and timelines. In line with this, Alavi and Zohdi [6] examined the use of EDA in contractor selection processes, specifically for residential projects, highlighting the importance of making data-informed decisions that balance cost and quality. Patel et al.[7] applied EDA in selecting contractors for affordable housing and found that systematic analysis of contractor-related data could lead to more informed decision-making, ultimately improving project efficiency and reducing costs.

The need for effective contractor selection is also highlighted by Lee et al. [8], who discussed how EDA could be used to assess contractor reliability and performance in residential construction projects. The study illustrated that such analysis helps to identify the best contractors based on historical performance, which is critical for reducing the risk of cost overruns and delays in affordable housing projects. Similarly, studies like those by Sharma et al.[9] and Tan and Gupta [10] examined the role of data analytics in reducing housing costs by identifying contractors who offer the best value for money. These studies emphasized the potential of using EDA to evaluate contractors’ historical data, assess their financial stability, and predict future performance, thereby making housing construction projects more affordable.

Another significant study by Joshi et al. [11] tackled the issue of homelessness in Madurai, Tamil Nadu, focusing on how contractor selection plays a critical role in housing affordability. By surveying 53 individuals, the researchers identified that many people in Madurai remained homeless because they were unable to find affordable and reliable builders. This study underscores the socio-economic importance of making informed decisions in contractor selection, as poor decisions often lead to suboptimal living conditions, further exacerbating homelessness. Bedi and Soni [12] and Zhang et al.[13] further supported this view by demonstrating that contractor pricing strategies, combined with performance data, are essential for achieving sustainable housing solutions that are both affordable and high-quality.

The concept of using EDA for contractor cost analysis and its application in addressing homelessness has gained substantial attention in recent years. Researchers such as Liu et al.[14] and Kumar et al. [15] focused on data-driven methods to improve contractor performance in the residential construction sector. Their work has shown that EDA can significantly contribute to reducing building costs by identifying contractors who deliver value and meet project specifications without compromising on quality[17]. Furthermore, Soni and Kapoor [16] have highlighted the importance of selecting contractors who adhere to project timelines and budgets, ensuring that the affordability of housing projects is not compromised[18].

The research from 2020 to 2024 consistently shows that EDA is a powerful tool in the contractor selection process. It allows for comprehensive analysis of contractor performance, pricing strategies, and their ability to meet project requirements efficiently[19]. The application of data analysis techniques helps to optimize contractor selection, thereby reducing costs, avoiding delays, and contributing to the affordability of residential housing projects. The findings from various studies collectively suggest that EDA offers a path toward creating more sustainable and affordable housing solutions, particularly for marginalized groups struggling with homelessness.

**PROBLEM STATEMENT AND OBJECTIVES**

This paper explores the economic factors influencing housing ownership in Madurai and their impact on the ability of individuals to construct their own homes. The study categorizes these economic factors into two primary groups: direct and indirect. Direct factors include income levels, employment opportunities, per capita income, and land availability and affordability based on its intended usage. Indirect factors involve land pricing, urban planning, construction methodologies, and relevant policies. Surveys in Madurai have highlighted that a significant portion of the population struggles with homeownership due to economic constraints. Public resources such as the Tamil Nadu Department of Economics and Statistics provide detailed housing data, including ownership statistics by region, while other reports, such as the District-Wise Housing Startup Index (HSUI), offer insights into house possession rates. Furthermore, agencies like the Asian Development Bank (ADB) have funded sustainable housing initiatives for urban poor populations in Tamil Nadu, though such resources are often overlooked in favor of informal networks.

The primary aim of this research is to educate individuals in Madurai on how to improve their home construction projects by providing structured and reliable information. Key factors such as material quality, builder reputation, timeframes, land utilization, and construction costs are critical to ensuring long-lasting and safe homes. Failure to prioritize these aspects can lead to disastrous outcomes, as illustrated by the Goripalayam building collapse in 2023, which was widely reported in The Hindu. To address this gap, this study aims to create a data-driven platform that provides detailed information about local engineering contractors. By analyzing factors such as cost per square foot, construction quality, customer reviews, services offered, and the brands used by builders, the study empowers individuals to make well-informed decisions about their home construction without relying on time-consuming or unreliable word-of-mouth recommendations. Ultimately, this resource aims to ensure that people can easily and confidently identify the best contractors for their housing needs, ensuring higher quality and better value.

**Data Collection and Exploratory Data Analysis (EDA)**

The data collection process for this project was meticulously designed to gather essential information about construction contractors in Madurai, focusing on factors such as pricing, service offerings, material quality, customer satisfaction, and contractor reputation. The data was sourced from various online contractor directories, government reports, online reviews, and public databases. These included contractor contact information, years of operation, pricing models, services provided (e.g., material sourcing, design, and project management), and feedback from previous clients. Additionally, government publications such as reports from the Tamil Nadu Department of Economics and Statistics and the District-Wise Housing Startup Index (HSUI) were utilized to gain insights into the regional housing trends.

Once the data was collected, it was subjected to Exploratory Data Analysis (EDA) to identify underlying patterns, trends, and potential outliers. EDA is an essential step in data analysis as it provides a deeper understanding of the dataset before applying any machine learning models. In this study, EDA was used to summarize the main characteristics of the data, visualize the relationships between different factors, and identify anomalies or patterns that could inform decision-making for potential homeowners.

Various Python libraries such as Pandas, Matplotlib, and Seaborn were employed to clean, manipulate, and visualize the collected data. Pandas helped in organizing the data and performing initial preprocessing tasks, including handling missing values, data types, and ensuring consistency across different entries. Matplotlib and Seaborn were then used to create visual representations, including bar charts, histograms, and scatter plots, which allowed for a clear comparison of contractor prices, customer reviews, and other critical factors. These visualizations were crucial in identifying trends in construction costs, service offerings, and customer satisfaction, enabling a clearer understanding of which contractors provided the best value in terms of price and quality.

The primary goal of EDA in this context was to identify key insights that could guide homeowners in selecting contractors. For example, visualizing the relationship between pricing and customer satisfaction helped reveal whether higher prices were correlated with better quality and customer reviews, or if lower-cost contractors were delivering comparable quality. Additionally, analyzing the distribution of contractor ratings and reviews provided valuable information about the consistency and reliability of different builders.

By incorporating EDA and visualizations, this study not only offers a more structured dataset but also provides actionable insights for homeowners. The visualized data aids in better decision-making by allowing users to assess contractor performance at a glance, making it easier for them to compare various options and select the most suitable builder for their needs. This approach empowers users to make informed decisions without relying solely on informal sources or word-of-mouth.

**Sources of Data Collection:**

The data for this study was collected from a variety of sources to ensure a comprehensive understanding of the construction landscape in Madurai. These sources include both primary and secondary data, as well as publicly available databases. Below is an overview of the key sources of data for this project:

1. **Online Contractor Directories:**

* Websites that list local contractors and construction service providers in Madurai were used as primary sources. These directories typically provide contact details, years of operation, and service offerings of contractors.
* Examples include local listings on platforms such as Justdial, Sulekha, and other regional contractor directories.

1. **Government Reports and Publications:**
   * Reports from the **Tamil Nadu Department of Economics and Statistics** provided valuable housing-related data, including statistics on housing ownership, construction trends, and regional variations in homeownership across Madurai.
   * The **District-Wise Housing Startup Index (HSUI)**, which tracks housing development and the number of new constructions in various regions of Tamil Nadu, offered insights into the regional housing market and trends.
   * Other reports from Tamil Nadu's urban planning and housing departments, detailing public and private housing statistics, urbanization rates, and construction permits, were utilized to understand the macroeconomic factors influencing the local housing market.
2. **Online Reviews and Customer Feedback Platforms:**
   * Websites like **Google Reviews** and **Houzz** were essential for gathering feedback on contractors from previous clients. These platforms provided ratings and reviews that helped assess customer satisfaction, service quality, and contractor reliability.
   * Social media platforms, such as Facebook and LinkedIn, also provided anecdotal evidence of contractors' work performance and reputation, contributing to the overall evaluation of their reliability and expertise.
3. **Building and Construction Industry Reports:**
   * Data from industry reports published by construction agencies and firms in Tamil Nadu helped supplement the dataset with information on pricing models, common construction materials, and industry standards in Madurai.
   * These reports provided insights into typical costs associated with building houses in the region, as well as common challenges faced by contractors and homeowners during construction projects.
4. **Local Construction Agencies and Contractors:**
   * Direct interviews and discussions with local contractors were conducted to gather specific pricing details, service offerings, and the types of materials they commonly use. This helped validate the data obtained from online directories and industry reports.
   * Local trade associations and builder associations also provided access to aggregated data on contractor performance and regional trends in construction.
5. **News Articles and Media Reports:**
   * Media outlets such as **The Hindu** and local newspapers were used to gather contextual data about significant construction-related events or issues in Madurai. For example, coverage of the Goripalayam building collapse in 2023, highlighted by The Hindu, provided insights into the importance of reliable contractors and quality assurance in the construction industry.

By utilizing a mix of these sources, the study was able to compile a robust dataset that encompasses various facets of the construction market in Madurai, including contractor performance, pricing, quality, and customer satisfaction. This diverse data collection approach ensures a well-rounded understanding of the factors influencing the selection of contractors and home construction in the region.

This research seeks to expose some of the problems that exist in the construction industry like low bid sub-contracting, wrong communication channel, high fixed cost, poor organization quality culture, traditional quality policy, un-defined strategic process quality management, lack of customer delight, discontinuity of improvement of process and technique and lack of time to ensure quality control, quality assurance and establishment of QMS. The research approach involves gathering contact details, description and the rating by clients on the contractor. Data that falls under this approach comprises of aspects such as sourcing every information available about the contractors, the rates offered and other factors that depict quality as well as the revenues for construction projects. Major factors will be described to reveal their impact on the decision in selecting a contractor and in the success of a construction.

Research objectives therefore include direct economic drivers, other indirect economic drivers, the government influence, the social and cultural environment, financial performance of the contractors, local economic effects, and the contributions of engineering contractors towards sustainable development. Concerning how the analysis is done, sources relating to the skill and experience of the contractor involved as well as price determination by price per square feet which becomes tricky since companies may have different layouts depicted may be an issue. Through accumulation and classification of information in obvious manner, this study intends to benefit potential house buyers with more reliable contractors who are capable of finishing the work in time with reasonable price and a satisfactory construction impression and also contribute to the local economy.

**RESULTS AND DISCUSSIONS**

The dataset provides an overview of construction firms in Madurai, with details like builder names, contact info, ratings, services, financials, and more. It includes 1000 entries in the first file and 56 in the second, with 20 columns each. Services offered range from construction and renovation to architecture and interior design. The average rating is 4.77, reflecting positive customer feedback. Firm establishment years span from 1986 to 2022, showing a mix of old and new companies. Annual turnover ranges widely, with some firms reaching up to 1 crore. The dataset also categorizes firms by legal status (e.g., Proprietor, Partnership, Limited Company) and includes insights into pricing (cost per sq.ft) and workforce size, offering valuable insights into the construction market in Madurai.

**Analysis of Rating Distribution and Patterns among Construction Builders**

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**Figure 1. Analysis of Rating Distribution and Patterns among Construction Builders**

The analysis of builder ratings in Madurai given in figure 1 reveals a generally high level of satisfaction, with most ratings being positive. A significant number of builders have received ratings above 4, indicating that customers are largely pleased with the services provided. The mean rating of 4.77 further supports this positive trend, suggesting that the majority of builders are effectively meeting customer expectations. while the overall ratings are strong, the few lower ratings present an opportunity for targeted improvements, allowing builders to enhance their reputation and better meet customer expectations.

**Correlation between Year of Establishment and Annual Turnover of Builders**

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**Figure 2. Correlation between Year of Establishment and Annual Turnover of Builders**

The analysis given in the figure 2 shows no significant correlation between the year of establishment and annual turnover of builders, with Pearson and Spearman correlation coefficients of 0.022 and -0.042, respectively, indicating very weak correlations. Both p-values (0.477 for Pearson and 0.172 for Spearman) are high, reinforcing the lack of statistical significance. This suggests that the age of a company does not strongly influence its turnover. Builders should focus on factors like market strategies, innovation, and operational efficiency rather than the year of establishment to improve financial performance.

**Relationship between Number of Employees, Annual Turnover, and Service Duration of Builders**

The data given in figure 3 reveals that the number of employees, annual turnover, and service duration are interconnected. Smaller teams (10-18 employees) can still achieve significant turnover, ranging from Rs. 50 Lakhs to Rs. 2 Crore, and service durations of 5 to 12 months, likely due to efficient operations or high-value projects. Larger teams (19-38 employees) typically handle more extensive projects, resulting in higher turnover (Rs. 1-2 Crore to Rs. 10-25 Crore) and longer service durations (9 to 12 months). The analysis suggests that while larger teams generally lead to higher turnover and longer service durations, smaller teams can maintain efficiency and focus on high-value projects, indicating a balance between efficiency and scale in the construction industry.

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**Figure 3. Relationship between Number of Employees, Annual Turnover, and Service Duration of Builder**

**Trends in Material Usage and Their Impact on Cost per Square Foot in Construction**

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**Figure 4. Trends in Material Usage and Their Impact on Cost per Square Foot in Construction**

The figure 4 reveals that builders commonly use high-quality materials such as "TMT Rod," "Ultra Tech Cement," and "M-Sand," each with a usage count of 19, indicating balanced material usage. While these materials reflect a trend toward quality and sustainability, the dataset lacks specific cost per square foot data, making it difficult to establish a clear relationship between material choice and cost. The visual analysis shows an equal distribution of materials, suggesting no strong preference, but insufficient data points prevent drawing definitive conclusions about the cost impact. However, premium materials likely increase the cost per square foot.

**Geographical Patterns in Builder Addresses and Their Relationship to Ratings and Services Offered**

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**Figure 5. Geographical Patterns in Builder Addresses and Their Relationship**

Figure 5 Builders in Madurai, particularly in areas like Anna Nagar, Vandiyur, and Tirumangalam, show a concentration of high-quality services and high ratings (4.8 to 5.0). These regions appear to be hubs for construction activity, with builders offering a wide range of services such as construction, renovation, and interior design, which correlates with their positive ratings. The competitive nature of these areas encourages builders to maintain high standards. Visual analysis of the data confirms that Madurai is a key location with a strong presence of reputable builders, offering diverse services and consistently high ratings.

**Frequency of Legal Statuses of Builders and Their Impact on Payment Terms and Service Duration**

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**Figure 6: Distribution of Legal Statuses of Builders and Their Impact on Payment Terms and Service Duration**

Figure 6 the legal status of construction firms significantly influences payment terms and service duration. Individual proprietors and sole proprietorships tend to offer more flexible and detailed payment terms, while partnership firms and limited companies often have more standardized payment structures. Service durations for individual proprietors and sole proprietorships vary between 5 to 12 months, indicating smaller projects, while limited companies generally handle longer projects, often lasting around 12 months. This suggests that legal status impacts both the scale of projects and the flexibility in payment arrangements.

**Variation in Included and Excluded Features in Construction Projects Based on Builder Ratings**

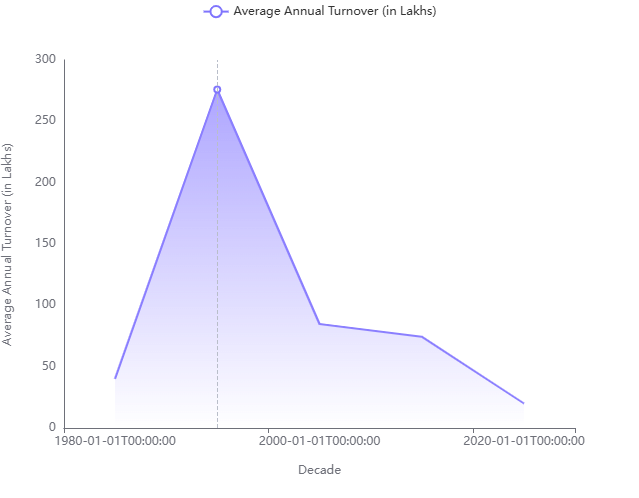
Figure 7. Builders with higher ratings (4.8 to 5.0) typically include essential features like borewell, sump, cupboard, compound wall, and septic tank in their projects, offering more comprehensive services with fewer exclusions. In contrast, lower-rated builders tend to exclude more features or focus on specialized areas, which may impact their ratings. This indicates that higher-rated builders prioritize meeting diverse client needs, while lower-rated ones may have limitations in their service offerings.

**Comparison of Average Annual Turnover for Builders Established in Different Decades**

Figure 8. Builders established in the 1990s have the highest average annual turnover at 275.95 lakhs, followed by the 1980s (40 lakhs), 2000s (84.79 lakhs), and 2010s (74.47 lakhs). The 2020s show the lowest average turnover at 20 lakhs, indicating a decline in turnover in recent years. The 1990s marked a peak, suggesting a period of significant growth or larger projects.

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**Figure 7: Distribution of Included and Excluded Features in Construction Projects Based on Builder Ratings**

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**Figure 8: Average Annual Turnover of Builders Established in Different Decade**

**Comprehensive table consolidating all findings, suggestions, and diagram details:**

**Table 1. Comprehensive table consolidating all findings, suggestions, and diagram details**

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Findings** | **Suggestions** | **Diagram Details** |
| **Material Usage Trends** | - Builders commonly use "TMT Rod," "Ultra Tech Cement," and "M-Sand."  - No clear correlation with cost per sq.ft. | - Builders should focus on maintaining high material quality. - Further data collection needed to assess cost impact. | **Bar Chart**: Equal distribution of materials used; no clear pattern for cost relationship. |
| **Geographical Distribution** | - Concentration of builders in Anna Nagar, Vandiyur, and Tirumangalam in Madurai. - High-rated builders spread across these regions. | - Builders in key regions should maintain high service standards. - Focus on customer satisfaction to maintain ratings. | **Map/Heat Map**: Concentration of builders in Madurai, highlighting high-rated areas and regions. |
| **Legal Status and Payment Terms** | - Individual Proprietors and Sole Proprietorships have flexible payment terms. - Partnership Firms and Limited Companies follow standardized terms. | - Smaller firms can focus on flexibility in payment terms to attract clients. - Larger firms continue with standardized contracts. | **Bar Chart**: Shows frequency of legal statuses and associated payment terms. |
| **Employee Count, Turnover & Service Duration** | - Larger teams (19-38 employees) correlate with higher turnover and longer service durations. - Smaller teams (10-18 employees) achieve significant turnover. | - Smaller firms focus on efficiency and high-value projects. - Larger firms manage larger projects with higher turnover. | **Scatter Plot**: Visualizes the relationship between number of employees, turnover, and service duration. |
| **Included vs. Excluded Features** | - High-rated builders offer comprehensive services with fewer exclusions. - Lower-rated builders have more exclusions. | - Builders should offer comprehensive services to improve ratings. - Minimize exclusions to appeal to a broader customer base. | **Bar Chart**: Shows distribution of included and excluded features for high-rated vs lower-rated builders. |
| **Turnover by Decade** | - Builders from the 1990s have the highest average turnover (275.95 lakhs). - Builders from the 2020s have the lowest turnover. | - Builders from newer decades should adapt to market conditions and innovate. - Builders from the 1990s should leverage experience for larger projects. | **Bar Chart**: Highlights average turnover for builders established in different decades, with a peak in the 1990s. |

**CONCLUSION**

Houses are essential in people's lives, and the building process is critical, especially for those looking to construct a home. This paper addresses the information gap by evaluating factors such as contractor reputation, material costs (sand, cement, rod, etc.), labor, customer service, and project duration. Both direct and indirect methods, including customer reviews, were used to gather data. Many homeowners face challenges in finding affordable contractors, often leaving their dreams unfulfilled. This research aims to help future homeowners select the right contractors, reducing issues like cost overruns, delays, and poor workmanship.In future research could apply machine learning to predict contractor performance and develop an interactive platform for contractor selection. Expanding the study to a wider area and including regulatory standards could provide more robust insights for homeowners.

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