Digital Egypt Pioneers

Ministry of Communications and Information Technology

Exploratory Data Analysis (EDA) Report for House Price Prediction Project

1. Introduction

The dataset used in this analysis, cleaned_house_data.csv, contains various features that can influence house prices. These features include both categorical and numerical data. The main target variable is Property_Sale_Price, which represents the sale price of properties. The goal of this EDA is to explore the dataset, identify important patterns, and detect relationships between features and house prices.

2. Dataset Overview

The dataset contains several features with both numerical and categorical variables. Here is an overview:

- **Total columns:** It contains a variety of attributes (numerical and categorical) number of columns 81.
- **Total rows:** Based on the dataset of house_prices.csv number of rows are 1460

General Information:

- **Data types:**
    - **Numerical**: Features such as ['Id', 'Dwell_Type', 'LotFrontage', 'LotArea', 'OverallQual', 'OverallCond', 'YearBuilt', 'YearRemodAdd', 'MasVnrArea', 'BsmtFinSF1', 'BsmtFinSF2', 'BsmtUnfSF', 'TotalBsmtSF', '1stFlrSF', '2ndFlrSF', 'LowQualFinSF', 'GrLivArea', 'BsmtFullBath', 'BsmtHalfBath', 'FullBath', 'HalfBath', 'BedroomAbvGr', 'KitchenAbvGr', 'TotRmsAbvGrd', 'Fireplaces', 'GarageYrBlt', 'GarageCars', 'GarageArea', 'WoodDeckSF', 'OpenPorchSF', 'EnclosedPorch', '3SsnPorch', 'ScreenPorch', 'PoolArea', 'MiscVal', 'MoSold', 'YrSold', 'Property_Sale_Price']
- **Categorical**: Features such as ['Zone_Class', 'Road_Type', 'Alley', 'Property_Shape', 'LandContour', 'Utilities', 'LotConfig', 'LandSlope', 'Neighborhood', 'Condition1', 'Condition2', 'Dwelling_Type', 'HouseStyle', 'RoofStyle', 'RoofMatl', 'Exterior1st', 'Exterior2nd', 'MasVnrType', 'ExterQual', 'ExterCond',

'Foundation', 'BsmtQual', 'BsmtCond', 'BsmtExposure', 'BsmtFinType1', 'BsmtFinType2', 'Heating', 'HeatingQC', 'CentralAir', 'Electrical', 'KitchenQual', 'Functional', 'FireplaceQu', 'GarageType', 'GarageFinish', 'GarageQual', 'GarageCond', 'PavedDrive', 'PoolQC', 'Fence', 'MiscFeature', 'SaleType', 'SaleCondition']

- **Null values:**
    - Significant missing values were detected for some columns. Example: MasVnrArea, Electrical, BsmtQual, GarageYrBlt (garage-related features), and others. These were highlighted and addressed.

4]:

	col	dtype	unique values	count unique	count null	percentage null
72	PoolQC	object	[nan, Ex, Fa, Gd]	3	1453	99.520548
74	MiscFeature	object	[nan, Shed, Gar2, Othr, TenC]	4	1406	96.301370
6	Alley	object	[nan, Grvl, Pave]	2	1369	93.767123
73	Fence	object	[nan, MnPrv, GdWo, GdPrv, MnWw]	4	1179	80.753425
25	MasVnrType	object	[BrkFace, nan, Stone, BrkCmn]	3	872	59.726027
57	FireplaceQu	object	[nan, TA, Gd, Fa, Ex, Po]	5	690	47.260274
3	LotFrontage	float64	[65.0, 80.0, 68.0, 60.0, 84.0, 85.0, 75.0, nan...	110	259	17.739726
58	GarageType	object	[Attchd, Detchd, BuiltIn, CarPort, nan, Basmen...	6	81	5.547945
59	GarageYrBlt	float64	[2003.0, 1976.0, 2001.0, 1998.0, 2000.0, 1993....	97	81	5.547945
60	GarageFinish	object	[RFn, Unf, Fin, nan]	3	81	5.547945
63	GarageQual	object	[TA, Fa, Gd, nan, Ex, Po]	5	81	5.547945
64	GarageCond	object	[TA, Fa, nan, Gd, Po, Ex]	5	81	5.547945
32	BsmtExposure	object	[No, Gd, Mn, Av, nan]	4	38	2.602740
35	BsmtFinType2	object	[Unf, BLQ, nan, ALQ, Rec, LwQ, GLQ]	6	38	2.602740
30	BsmtQual	object	[Gd, TA, Ex, nan, Fa]	4	37	2.534247
31	BsmtCond	object	[TA, Gd, nan, Fa, Po]	4	37	2.534247
33	BsmtFinType1	object	[GLQ, ALQ, Unf, Rec, BLQ, nan, LwQ]	6	37	2.534247
26	MasVnrArea	float64	[196.0, 0.0, 162.0, 350.0, 186.0, 240.0, 286.0...	327	8	0.547945
42	Electrical	object	[SBrkr, FuseF, FuseA, FuseP, Mix, nan]	5	1	0.068493
0	Id	int64	[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14...	1460	0	0.000000

3. Descriptive Statistics

The summary statistics for numerical variables provide insights into the data's distribution. Some key highlights:

- **Mean and median (50th percentile)** help understand the central tendency.
- **Min and max values** show the range, and any extreme outliers can be observed.

- **Standard deviation** measures the spread of the data, with certain features exhibiting high variability.
  - **Descriptive analysis for numerical data:**

	count	mean	std	min	25%	50%	75%	max
Id	1460.0	730.500000	421.610009	1.0	365.75	730.5	1095.25	1460.0
Dwell_Type	1460.0	56.897260	42.300571	20.0	20.00	50.0	70.00	190.0
LotFrontage	1201.0	70.049958	24.284752	21.0	59.00	69.0	80.00	313.0
LotArea	1460.0	10516.828082	9981.264932	1300.0	7553.50	9478.5	11601.50	215245.0
OverallQual	1460.0	6.099315	1.382997	1.0	5.00	6.0	7.00	10.0
OverallCond	1460.0	5.575342	1.112799	1.0	5.00	5.0	6.00	9.0
YearBuilt	1460.0	1971.267808	30.202904	1872.0	1954.00	1973.0	2000.00	2010.0
YearRemodAdd	1460.0	1984.865753	20.645407	1950.0	1967.00	1994.0	2004.00	2010.0
MasVnrArea	1452.0	103.685262	181.066207	0.0	0.00	0.0	166.00	1600.0
BsmtFinSF1	1460.0	443.639726	456.098091	0.0	0.00	383.5	712.25	5644.0
BsmtFinSF2	1460.0	46.549315	161.319273	0.0	0.00	0.0	0.00	1474.0
BsmtUnfSF	1460.0	567.240411	441.866955	0.0	223.00	477.5	808.00	2336.0
TotalBsmtSF	1460.0	1057.429452	438.705324	0.0	795.75	991.5	1298.25	6110.0
1stFlrSF	1460.0	1162.626712	386.587738	334.0	882.00	1087.0	1391.25	4692.0
2ndFlrSF	1460.0	346.992466	436.528436	0.0	0.00	0.0	728.00	2065.0
LowQualFinSF	1460.0	5.844521	48.623081	0.0	0.00	0.0	0.00	572.0
GrLivArea	1460.0	1515.463699	525.480383	334.0	1129.50	1464.0	1776.75	5642.0
BsmtFullBath	1460.0	0.425342	0.518911	0.0	0.00	0.0	1.00	3.0
BsmtHalfBath	1460.0	0.057534	0.238753	0.0	0.00	0.0	0.00	2.0
FullBath	1460.0	1.565068	0.550916	0.0	1.00	2.0	2.00	3.0
HalfBath	1460.0	0.382877	0.502885	0.0	0.00	0.0	1.00	2.0
BedroomAbvGr	1460.0	2.866438	0.815778	0.0	2.00	3.0	3.00	8.0
KitchenAbvGr	1460.0	1.046575	0.220338	0.0	1.00	1.0	1.00	3.0
TotRmsAbvGrd	1460.0	6.517808	1.625393	2.0	5.00	6.0	7.00	14.0
Fireplaces	1460.0	0.613014	0.644666	0.0	0.00	1.0	1.00	3.0
GarageYrBlt	1379.0	1978.506164	24.689725	1900.0	1961.00	1980.0	2002.00	2010.0
GarageCars	1460.0	1.767123	0.747315	0.0	1.00	2.0	2.00	4.0
GarageArea	1460.0	472.980137	213.804841	0.0	334.50	480.0	576.00	1418.0
WoodDeckSF	1460.0	94.244521	125.338794	0.0	0.00	0.0	168.00	857.0
OpenPorchSF	1460.0	46.660274	66.256028	0.0	0.00	25.0	68.00	547.0
EnclosedPorch	1460.0	21.954110	61.119149	0.0	0.00	0.0	0.00	552.0
3SsnPorch	1460.0	3.409589	29.317331	0.0	0.00	0.0	0.00	508.0
ScreenPorch	1460.0	15.060959	55.757415	0.0	0.00	0.0	0.00	480.0
PoolArea	1460.0	2.758904	40.177307	0.0	0.00	0.0	0.00	738.0
MiscVal	1460.0	43.489041	496.123024	0.0	0.00	0.0	0.00	15500.0
MoSold	1460.0	6.321918	2.703626	1.0	5.00	6.0	8.00	12.0
YrSold	1460.0	2007.815753	1.328095	2006.0	2007.00	2008.0	2009.00	2010.0
Property_Sale_Price	1460.0	180921.195890	79442.502883	34900.0	129975.00	163000.0	214000.00	755000.0

- **Descriptive analysis for Categorical data**:

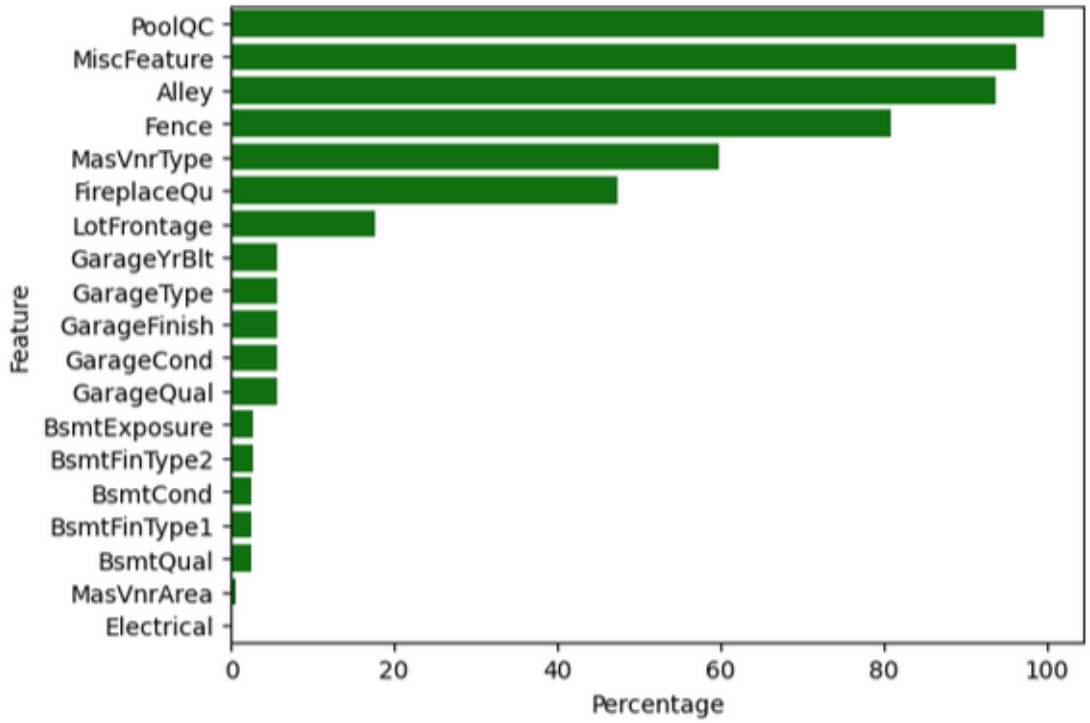
	count	unique	top	freq
Zone_Class	1460	5	RL	1151
Road_Type	1460	2	Pave	1454
Alley	91	2	Grvl	50
Property_Shape	1460	4	Reg	925
LandContour	1460	4	Lvl	1311
Utilities	1460	2	AllPub	1459
LotConfig	1460	5	Inside	1052
LandSlope	1460	3	Gtl	1382
Neighborhood	1460	25	NAmes	225
Condition1	1460	9	Norm	1260
Condition2	1460	8	Norm	1445
Dwelling_Type	1460	5	1Fam	1220
HouseStyle	1460	8	1Story	726
RoofStyle	1460	6	Gable	1141
RoofMatl	1460	8	CompShg	1434
Exterior1st	1460	15	VinylSd	515
Exterior2nd	1460	16	VinylSd	504
MasVnrType	588	3	BrkFace	445
ExterQual	1460	4	TA	906
ExterCond	1460	5	TA	1282
Foundation	1460	6	PConc	647
BsmtQual	1423	4	TA	649
BsmtCond	1423	4	TA	1311
BsmtExposure	1422	4	No	953
BsmtFinType1	1423	6	Unf	430
BsmtFinType2	1422	6	Unf	1256
Heating	1460	6	GasA	1428
HeatingQC	1460	5	Ex	741
CentralAir	1460	2	Y	1365
Electrical	1459	5	SBrkr	1334
KitchenQual	1460	4	TA	735
Functional	1460	7	Typ	1360
FireplaceQu	770	5	Gd	380
GarageType	1379	6	Attchd	870
GarageFinish	1379	3	Unf	605
GarageQual	1379	5	TA	1311
GarageCond	1379	5	TA	1326
PavedDrive	1460	3	Y	1340
PoolQC	7	3	Gd	3
Fence	281	4	MnPrv	157
MiscFeature	54	4	Shed	49
SaleType	1460	9	WD	1267
SaleCondition	1460	6	Normal	1198

4. Missing Data Analysis

Missing values were found in several features. Here's a breakdown:

- MasVnrArea and Electrical have missing values, affecting their usability.
- The basement-related features (BsmtCond, BsmtQual, BsmtFinType2, BsmtExposure) also show significant null percentages.
- Handling missing values for these critical features is important as they may impact model performance.

A bar plot was used to visualize the percentage of missing data for each feature, making it easier to identify columns with missing data.



5. Correlation Analysis (Numerical Variables)

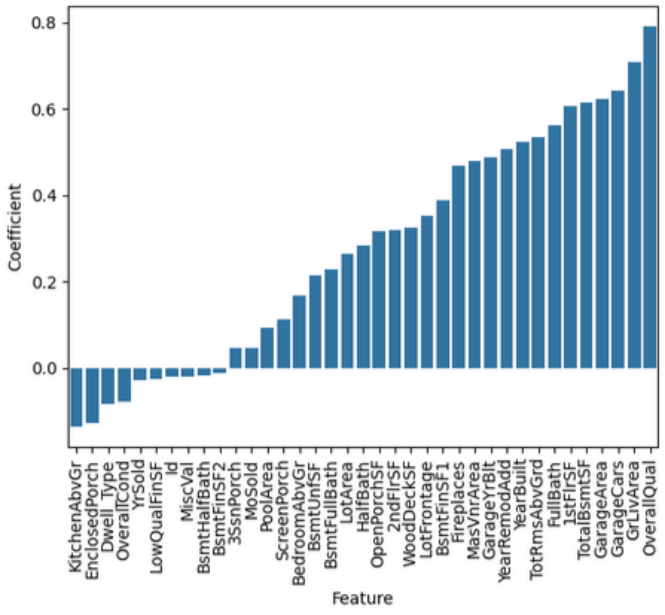
The correlation matrix was generated to analyze the relationships between numerical variables.

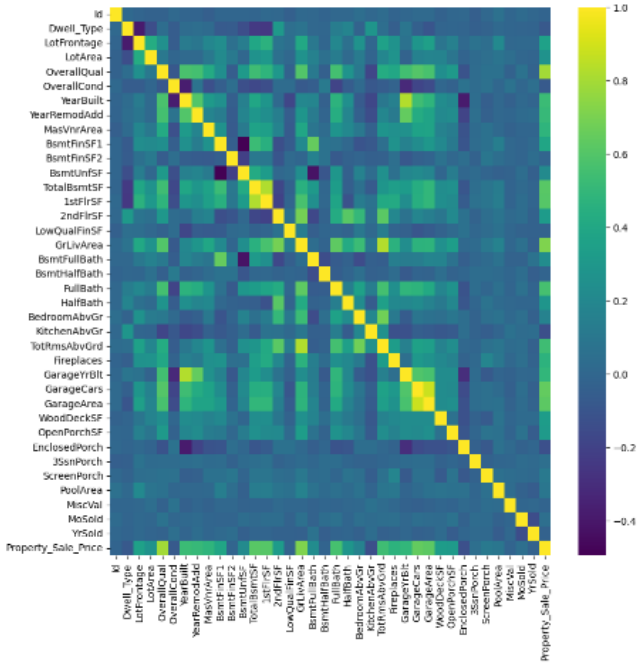
- **Highly correlated features with Property_Sale_Price:**

- Features like OverallQual, GrLivArea, and GarageCars show strong positive correlations with house prices.
- Conversely, features like EnclosedPorch and OverallCond have weaker correlations.

A **heatmap** was plotted to visualize the correlations between numerical variables. This revealed several strong relationships, guiding us toward feature importance for predictive modeling.

- **Top correlated features**: We used the absolute correlation matrix to filter the top 40 most correlated pairs, helping identify multicollinearity and important variables for the prediction model.



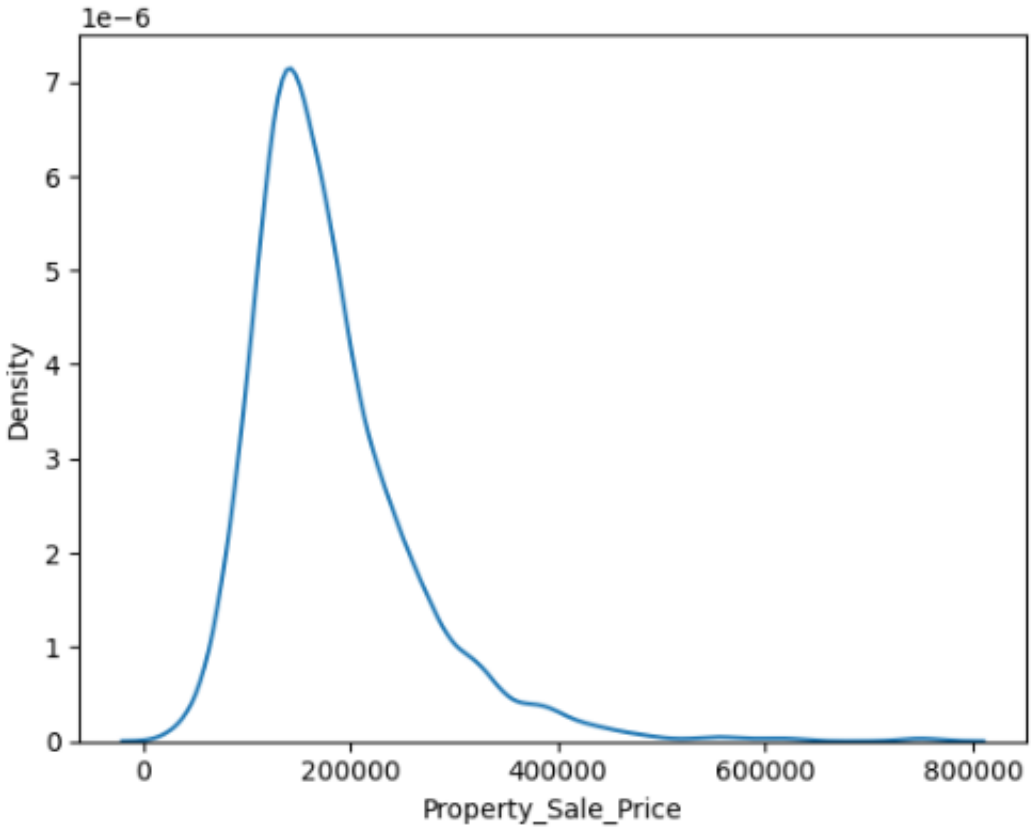



```
Property_Sale_Price    1.000000
OverallQual            0.796088
GrLivArea              0.693550
GarageCars             0.648683
GarageArea             0.631098
TotalBsmtSF            0.609097
1stFlrSF               0.599554
FullBath               0.557775
YearBuilt              0.534943
TotRmsAbvGrd           0.533466
YearRemodAdd           0.521141
MasVnrArea             0.471845
Fireplaces             0.463872
BsmtFinSF1             0.373409
LotFrontage            0.334225
OpenPorchSF            0.324959
WoodDeckSF             0.322209
2ndFlrSF               0.296304
HalfBath               0.282741
GarageYrBlt            0.268311
LotArea                0.265523
BsmtFullBath           0.234306
BsmtUnfSF              0.220669
BedroomAbvGr           0.160533
ScreenPorch            0.118327
MoSold                 0.057045
3SsnPorch              0.047416
PoolArea               0.028630
```

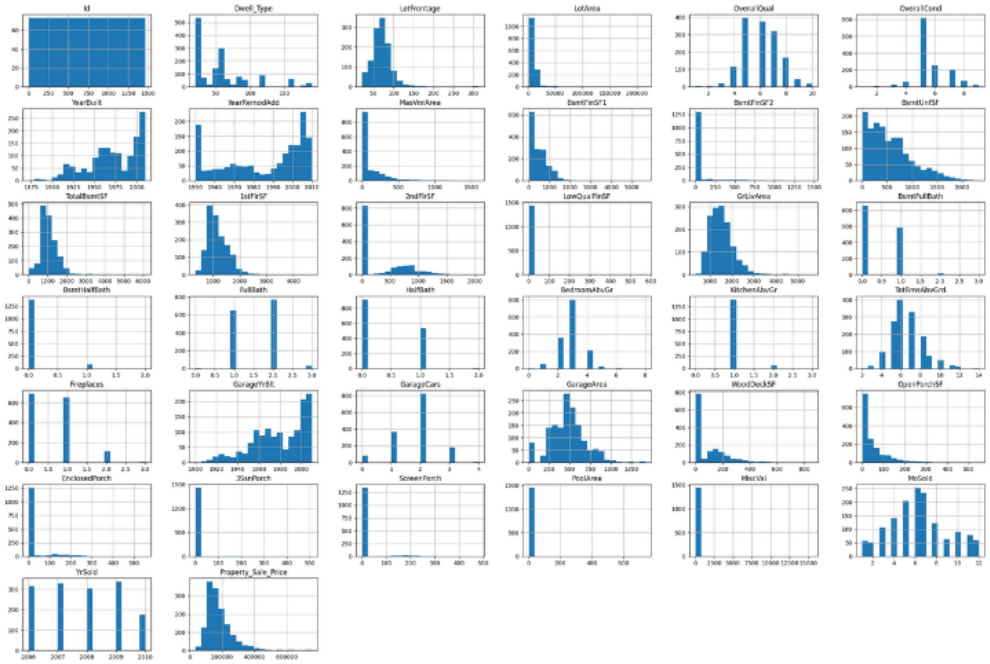
```
BsmtFinSF2            -0.008892
MiscVal               -0.021094
YrSold                -0.023725
LowQualFinSF          -0.025347
BsmtHalfBath          -0.036785
OverallCond           -0.080180
Dwell_Type            -0.088116
EnclosedPorch         -0.129757
KitchenAbvGr          -0.138839
Name: Property_Sale_Price, dtype: fl
```

6. Univariate Analysis

- **Numerical features:**
    - The distribution of the target variable (Property_Sale_Price) was visualized using a **histogram** and **kdeplot**. This revealed a positively skewed distribution, indicating that most houses are sold at lower prices, with fewer properties in higher price ranges.



- Other numerical variables such as LotFrontage, GarageYrBlt, and MasVnrArea were visualized using histograms to understand their distribution.



- **Categorical features:**
  - Each categorical feature was analyzed, showing the unique values and their counts.

```
Zone_Class
['RL' 'RM' 'C (all)' 'FV' 'RH']
Zone_Class
RL         1151
RM          218
FV           65
RH           16
C (all)      10
Name: count, dtype: int64
Road_Type
['Pave' 'Grvl']
Road_Type
Pave    1454
Grvl       6
Name: count, dtype: int64
Alley
[nan 'Grvl' 'Pave']
Alley
Grvl    50
Pave    41
Name: count, dtype: int64
Property_Shape
['Reg' 'IR1' 'IR2' 'IR3']
Property_Shape
Reg    925
IR1    484
IR2     41
IR3     10
Name: count, dtype: int64
```

```
LandContour
['Lvl' 'Bnk' 'Low' 'HLS']
LandContour
Lvl    1311
Bnk      63
HLS      50
Low      36
Name: count, dtype: int64
Utilities
['AllPub' 'NoSeWa']
Utilities
AllPub    1459
NoSeWa       1
Name: count, dtype: int64
LotConfig
['Inside' 'FR2' 'Corner' 'CulDSac' 'FR3']
LotConfig
Inside     1052
Corner      263
CulDSac      94
FR2          47
FR3           4
Name: count, dtype: int64
LandSlope
['Gtl' 'Mod' 'Sev']
LandSlope
Gtl    1382
Mod      65
Sev      13
Name: count, dtype: int64
```

```
Neighborhood
['CollgCr' 'Veenker' 'Crawfor' 'NoRidge' 'Mitchel' 'Somerst' 'NWAmes'
 'OldTown' 'BrkSide' 'Sawyer' 'NridgHt' 'NAmes' 'SawyerW' 'IDOTRR'
 'MeadowV' 'Edwards' 'Timber' 'Gilbert' 'StoneBr' 'ClearCr' 'NPkVill'
 'Blmngtn' 'BrDale' 'SWISU' 'Blueste']
Neighborhood
NAmes      225
CollgCr    150
OldTown    113
Edwards    100
Somerst     86
Gilbert     79
NridgHt     77
Sawyer      74
NWAmes      73
SawyerW     59
BrkSide     58
Crawfor     51
Mitchel     49
NoRidge     41
Timber      38
IDOTRR      37
ClearCr     28
SWISU       25
StoneBr     25
Blmngtn     17
MeadowV     17
BrDale      16
Veenker     11
NPkVill      9
Blueste      2
Name: count, dtype: int64
```

```
Condition1
['Norm' 'Feedr' 'PosN' 'Artery' 'RRAe' 'RRNn' 'RRAn' 'PosA' 'RRNe']
Condition1
Norm      1260
Feedr       81
Artery      48
RRAn        26
PosN        19
RRAe        11
PosA         8
RRNn         5
RRNe         2
Name: count, dtype: int64
Condition2
['Norm' 'Artery' 'RRNn' 'Feedr' 'PosN' 'PosA' 'RRAn' 'RRAe']
Condition2
Norm      1445
Feedr        6
Artery       2
RRNn         2
PosN         2
PosA         1
RRAn         1
RRAe         1
Name: count, dtype: int64
```

```
Dwelling_Type
['1Fam' '2fmCon' 'Duplex' 'TwnhsE' 'Twnhs']
Dwelling_Type
1Fam      1220
TwnhsE     114
Duplex      52
Twnhs       43
2fmCon      31
Name: count, dtype: int64
HouseStyle
['2Story' '1Story' '1.5Fin' '1.5Unf' 'SFoyer' 'SLvl' '2.5Unf' '2.5Fin']
HouseStyle
1Story    726
2Story    445
1.5Fin    154
SLvl       65
SFoyer     37
1.5Unf     14
2.5Unf     11
2.5Fin      8
Name: count, dtype: int64
RoofStyle
['Gable' 'Hip' 'Gambrel' 'Mansard' 'Flat' 'Shed']
RoofStyle
Gable      1141
Hip         286
Flat         13
Gambrel      11
Mansard       7
Shed          2
Name: count, dtype: int64
```

```
RoofMatl
['CompShg' 'WdShngl' 'Metal' 'WdShake' 'Membran' 'Tar&Grv' 'Roll'
 'ClyTile']
RoofMatl
CompShg    1434
Tar&Grv      11
WdShngl       6
WdShake       5
Metal         1
Membran       1
Roll          1
ClyTile       1
Name: count, dtype: int64
Exterior1st
['VinylSd' 'MetalSd' 'Wd Sdng' 'HdBoard' 'BrkFace' 'WdShing' 'CemntBd'
 'Plywood' 'AsbShng' 'Stucco' 'BrkComm' 'AsphShn' 'Stone' 'ImStucc'
 'CBlock']
Exterior1st
VinylSd    515
HdBoard    222
MetalSd    220
Wd Sdng    206
Plywood    108
CemntBd     61
BrkFace     50
WdShing     26
Stucco      25
AsbShng     20
BrkComm      2
Stone        2
AsphShn      1
ImStucc      1
CBlock       1
```

7. Bivariate Analysis

- **Sale Price vs Numerical Features:** A barplot showing the **correlation coefficients** between Property_Sale_Price and numerical features highlighted features like OverallQual, GrLivArea, and GarageCars as the most significant predictors for house prices.

- **Categorical Features vs Sale Price:** The Dash application allowed for interactive plotting of categorical features. A **count plot**, **scatter plot**, and **mean sale price plot** were implemented for deeper analysis:
    - Neighborhood, GarageType, and other categorical variables were analyzed for their impact on house prices.
    - Mean sale price per category helped understand which categories have higher average property prices.

8. Multivariate Analysis

By examining correlation between features

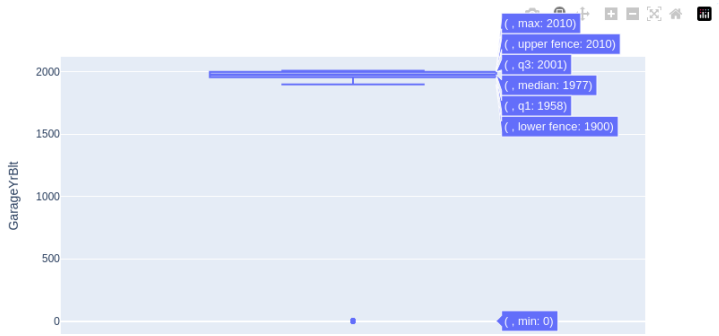
```
GarageArea           GarageCars           0.882475
GarageYrBlt          YearBuilt            0.825667
TotRmsAbvGrd         GrLivArea            0.825489
1stFlrSF             TotalBsmtSF          0.819530
OverallQual          Property_Sale_Price  0.790982
GrLivArea            Property_Sale_Price  0.708624
                     2ndFlrSF             0.687501
BedroomAbvGr         TotRmsAbvGrd         0.676620
BsmtFinSF1           BsmtFullBath         0.649212
GarageYrBlt          YearRemodAdd         0.642277
Property_Sale_Price  GarageCars           0.640409
FullBath             GrLivArea            0.630012
Property_Sale_Price  GarageArea           0.623431
TotRmsAbvGrd         2ndFlrSF             0.616423
TotalBsmtSF          Property_Sale_Price  0.613581
2ndFlrSF             HalfBath             0.609707
Property_Sale_Price  1stFlrSF             0.605852
OverallQual          GarageCars           0.600671
                     GrLivArea            0.593007
YearBuilt            YearRemodAdd         0.592855
dtype: float64
```

9. Outliers

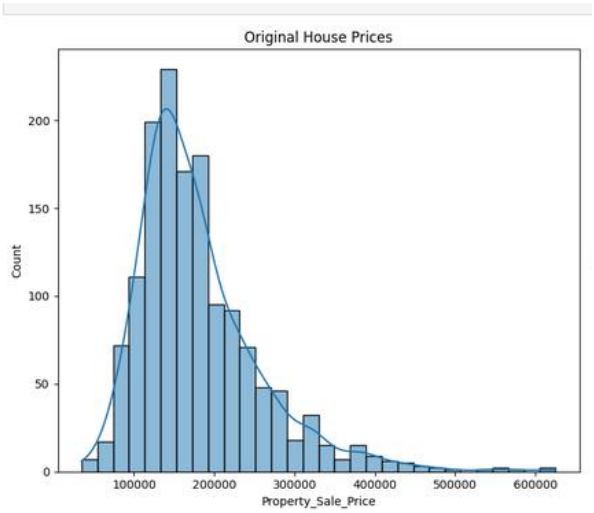
Outliers were identified using box plots, particularly in features like GrLivArea, OverallQual, and SaleCondition. These outliers could be influential in skewing the results of predictive models and may need to be addressed.

10. Feature Engineering Considerations

- Features such as GarageYrBlt features may need additional preprocessing due to their missing values and categorical nature.



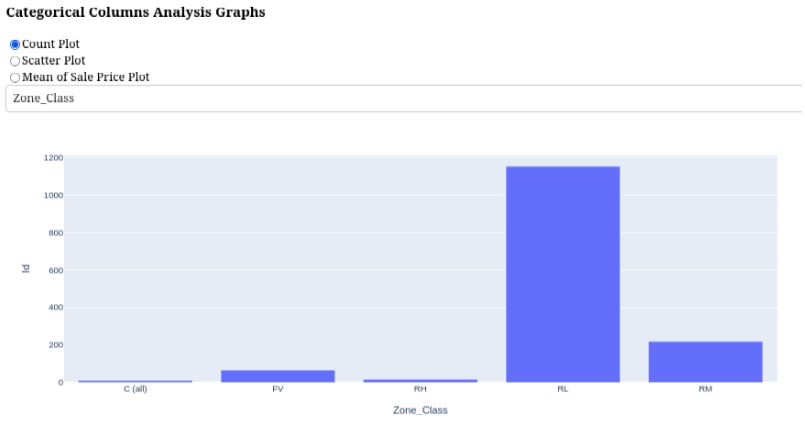
- Log transformation was performed on Property_Sale_Price to reduce skewness for model training.



11. Visualizations Using Dash

To enable interactive analysis, a Dash application was built to visualize both categorical and numerical features:

- For categorical features, a count plot, scatter plot, and mean sale price plot were implemented to explore their distributions and relationships with sale prices.



- For numerical features, a box plot, distribution plot, and scatter plot were implemented to visualize the spread and relationships of various features with house prices.

12. Conclusions

The EDA reveals several key insights about house prices:

- **Strong predictive features**: OverallQual, GrLivArea, and GarageCars are strongly correlated with house prices and should be considered as primary features in any predictive model.
- **Missing values**: Critical features with missing data need to be handled properly before training the model.