***Executive Summary of AHU Price Model***

**Objective**

A multiple linear regression model to explain and predict the sales price of commercial Air Handling Units (AHUs) was built in Okarche. By analyzing 3,992 AHU records (From invoice date Jan 1st , 2021 to April 30th, 2025), we aimed to identify which product features, configurations, and labor inputs most strongly drive final unit price.

**Business Implications**

Airflow Capacity (DesignCFM = +$0.45/CFM)  
Larger CFM adds $450 per 1,000 CFM.  
Implication: Investing in higher-capacity blowers/coils drives revenue—consider marketing “premium high‐CFM” packages to customers with larger spaces.

Air Tunnel Count (–$8,013/tunnel)  
Each additional tunnel reduces price by about $8 K.  
Implication: Multi‐tunnel designs lower unit cost; promote “modular‐tunnel” configurations to cost‐sensitive buyers or leverage simpler single tunnels to justify higher prices.

Coil Counts (dr\_CoilCount = +$7,066/coil; No\_of\_Total\_UDC\_in\_Airtunnel = +$7,626/coil)  
Every coil adds ~$7 K.  
Implication: Bundling extra coils (e.g., higher‐efficiency heat exchange) can be a clear upsell. Track how many customers opt for 2+ coils and use that for margin optimization.

Fan Assemblies (dr\_FanWallFanCount = +$4,045; dr\_PlenumFanCount = +$3,758)  
Each fan adds roughly $4 K.  
Implication: Promote “fan‐wall” or “plenum fan” upgrades to customers needing redundancy or better airflow control—higher margins per fan.

Footprint & Sections (dr\_AhuWidth = +$130/in; dr\_AhuSectionCount = +$2,488/section)  
One‐inch width adds $130; each extra section adds ~$2.5 K.  
Implication: Educate sales on upselling slightly wider units or additional sections (e.g., maintenance access) to lift average order value.

ERP Labor Hours (Base = –$1,388/hr; Fanwall = –$904/hr; Total = +$543/hr)  
Base and Fanwall hours reduce billed price, while total hours net to +$543/hr.  
Implication: Streamline Base/Fanwall labor to minimize down‐charges or reclassify tasks under billable categories (unit/cabinet/parts hours) to capture positive pass‐through.

Module & Accessories (Filter = +$4,669)  
Adding a filter module reliably adds ~$4.7 K.

Implication: Package filter racks as “standard” or “recommended” option—small incremental cost for customer, healthy margin for us.

Code Compliance (Miami‐Dade = +$9,525; OSHPD = +$19,040)  
Upgrading to hurricane vs. seismic compliance yields large premium.  
Implication: Target markets (e.g., Florida, California) with clear messaging on ROI of compliance. Use these options to justify premium pricing in regulated regions.

Air Tunnel Complexity (Non‐Complex = –$12,860)  
Choosing “Non‐Complex” tunnels reduces price by ~$12.9 K.  
Implication: Offer “Complex” tunnels as default, then discount to “Non‐Complex” only when necessary—preserves margin.

Configuration Flags (Galvanized = –$5,966; Indoor = –$3,059; Knockdown = –$2,733)  
Standard galvanized, indoor‐only, or knockdown shipping each lower unit price.

Factory Discount (–$1.45 per $1 discount)  
Every $1 discount costs $1.45 in revenue—margins erode.  
Implication: Tighten discounting policies.

**Recommendations:**

* Point out extra coils, fan-wall upgrades, filter modules, and code compliance in every quote.
* Optimize Labor Billing: Avoid logging hours under Base or Fanwall labor since those lower the price. Instead, record more time under general billable tasks (which pass through as $543/hour).  
  Keep better track of labor costs so we know exactly how much to charge customers.
* Use “Complex” tunnels and outdoor-ready finishes as premium examples, then offer “Non-Complex” or indoor-only as lower-cost options.
* Control Discounts: Stick to list price whenever possible. If a discount is needed, make customers add something extra (like a filter or extra fan) so we don’t lose too much margin (every $1 off costs $1.45).
* Market Region-Specific Compliance: In Florida and California, treat Miami-Dade and OSHPD code upgrades as must-haves—customers there expect it, so hold firm on price.

**Overall Model Performance**

Sample Size: 3,992 AHUs after data cleaning and outlier removal.

Predictors: 21 variables covering airflow capacity, component counts, cabinet design codes, material finishes, and ERP‐recorded labor hours.

R² = 0.868 (Adj. R² = 0.868): This means the model explains 86.8% of the variation in AHU price.

F‐statistic = 1,248 (p < 0.001) confirms that, collectively, the chosen variables are highly significant in explaining price.

The Durbin–Watson statistic is 1.97, indicating no serious autocorrelation in residuals.

A screenshot of a computer

AI-generated content may be incorrect.

**Key Price Drivers**

Below we highlight the most economically meaningful effects (all listed p‐values are < 0.05, unless noted). Each coefficient shows how much price changes (in USD) when that feature changes by one unit, all else equal.

a. Airflow Capacity & Core Components

* DesignCFM (Airflow Capacity):
  + Coefficient = $0.45 per CFM
  + Interpretation: Increasing design capacity by 1,000 CFM adds approximately $450 to the unit’s price.
  + Rationale: Larger airflow requires bigger blowers, heavier framing, more insulation, and higher‐capacity coils.
* No\_of\_AirTunnels:
  + Coefficient = –$8,013 per tunnel
  + Interpretation: Adding a single additional air tunnel *reduces* price by roughly $8,000, holding all else constant. (Or somehow AHUs with low count Air tunnels are getting sold for a better price)
  + Rationale: More tunnels often imply smaller, simpler fans or coils per tunnel, reducing cost per tunnel compared to a single large‐tunnel design.
* No\_of\_Total\_UDC\_in\_Airtunnel (Number of Coils in Tunnel):
  + Coefficient = $7,626 per coil
  + Interpretation: Adding one user defined component to an air tunnel adds $7,600 to price.
* dr\_CoilCount (Total Coil Count):
  + Coefficient = $7,066 per coil
  + Interpretation: Every additional coil (across the entire AHU) adds roughly $7,066.
* dr\_FanWallFanCount:
  + Coefficient = $4,045 per fan in a fan‐wall
  + Interpretation: Each extra fan in a fan‐wall assembly adds approximately $4,045 to the price.
* dr\_PlenumFanCount:
  + Coefficient = $3,758 per plenum fan
  + Interpretation: Each additional plenum fan adds $3,758.

b. AHU Footprint & Sections

* dr\_AhuWidth (Cabinet Width):
  + Coefficient = $130 per inch
  + Interpretation: Widening the AHU by one inch increases price by $130.
  + Rationale: Larger cabinet panels, heavier structural framing, and higher shipping costs.
* dr\_AhuSectionCount:
  + Coefficient = $2,488 per section
  + Interpretation: Adding one cabinet section adds $2,488.

c. ERP Labor Hours (Cost Allocations)

* Base Hours ERP(2000):
  + Coefficient = –$1,388 per hour
  + Interpretation: reduces billed price by roughly $1,388 for each base hour logged.
* Fanwall Hours ERP(4000):
  + Coefficient = –$904 per hour
  + Interpretation: Fan‐wall‐related ERP labor reduces billed price by $904 per recorded Fanwall hour.
* Total Hours (Sum of all ERP hours):
  + Coefficient = $543 per hour
  + Interpretation: On aggregate, each billable ERP hour adds approximately $543 to price.
  + Rationale: While specific ERP categories (Base, Fanwall) show negative pass‐through, the total hours signal overall labor content (Unit, Door, Cabinet, Parts and subassembly hours) that customers do pay for—thus a net positive pass‐through of $543/hour.

d. Module & Accessory Options

* Filter:
  + Coefficient = $4,669
  + Interpretation: Adding a filter module (e.g., MERV‐rated filter rack) adds $4,669 to the AHU price.

e. Cabinet Design & Code Compliance

* Cabinet\_Design\_Miami‐Dade:
  + Coefficient = $9,525
  + Interpretation: Upgrading the cabinet to meet Miami‐Dade hurricane code adds $9,525.
  + Note: This is relative to our baseline cabinet (e.g., “Standard”).
* Cabinet\_Design\_OSHPD:
  + Coefficient = $19,040
  + Interpretation: Upgrading to OSHPD (California seismic) code compliance adds $19,040.
  + Rationale: OSHPD requires heavier gauge steel, more robust anchoring, and specialized seismic calculations.
* Air\_Tunnels\_Category\_Non‐Complex AT:
  + Coefficient = –$12,860
  + Interpretation: When a customer chooses a “Non‐Complex” air tunnel design (versus “Complex”) we loose approximately $12,860.
  + Rationale: Complex tunnels often require tight tolerances, special welding, or multiple mixing sections that raise cost.

f. Configuration Flags (Boolean Options)

For each of these, the coefficient is the dollar impact when the flag = 1 versus 0 (holding other factors constant):

* dr\_IsGalv\_1.0 (Galvanized Finish): –$5,966
  + Interpretation: If the unit is built with standard galvanized steel rather than a pricier finish (e.g., stainless), price falls by $5,966 relative to the baseline finish.
* dr\_IsIndoorUse\_1.0 (Indoor‐Only AHU): –$3,059
  + Interpretation: Configuring the unit for indoor‐only use (no weather enclosure) reduces price by $3,059.
* dr\_IsKnockdown\_1.0 (Knockdown Shipping): –$2,733
  + Interpretation: If the AHU is shipped as a “knockdown” (disassembled) unit instead of fully assembled, price is $2,733 lower.

g. Factory Discount

* dr\_factorydiscount:
  + Coefficient = –$1.45 per $1 discount
  + Interpretation: For every $1 of factory‐level discount given, the final invoice price drops by $1.45, implying that not only is the discount passed through, but there is also an incremental margin dilution of $0.45.

**Model Diagnostics & Assumptions**

* Residual Distribution (Normality):
  + We conducted Shapiro–Wilk and Lilliefors (KS) tests on residuals after dropping insignificant predictors. Both tests yielded p‐values > 0.05, indicating we cannot reject normality—our residuals are acceptably normal for inference.
  + Visual checks (histogram + overlaid normal curve, Q–Q plot) confirm only mild tail heaviness, which is typical for AHU price data but well within acceptable bounds.
* Homoscedasticity (Constant Variance):
  + Residuals plotted against fitted values show no obvious “fanning” pattern—variance remains reasonably constant across predicted price levels.
* Multicollinearity:
  + We removed predictors with extremely high VIF or perfect collinearity. Remaining VIFs are all below 7, ensuring stable coefficient estimates.

**Next Steps**

1. Model Extension & Validation
   * Deploy this model on a hold‐out sample of new AHU quotes to validate predictive accuracy.
   * Track actual quote‐to‐order variance to see if coefficients remain stable over time.
2. Explore Interaction Effects
   * Consider interactions such as DesignCFM × CoilCount or Cabinet\_Design × dr\_IsGalv to capture non‐linear “bulk discount” effects on larger units or finishes.