Strategy Building Documentation

Purpose of the Project

The purpose of this project is to present the complete process of building a quantitative trading strategy. It covers each stage of development starting from forming a hypothesis, selecting suitable indicators and methods, understanding the trading environment, and addressing practical market limitations. It also highlights how to handle pivots when strategies fail and the role of backtesting and analysis in validating ideas.

The goal is to provide students with a structured overview of the end-to-end journey, from idea generation to performance evaluation.

1. Developing the Initial Trading Hypothesis

The hypothesis was to use a **long–short strategy**. The idea is to analyze stock data and indicators to identify:

- **Top up-trending stocks** → take long positions
- **Most down-trending stocks** → take short positions

This approach helps balance risks, as gains from one side can offset losses from the other, making the overall performance less affected by market instabilities and resulting in a smoother equity curve.

2. Choosing the Right Stock Universe

For this strategy, I chose the **NIFTY 50 stock universe**. This choice was made because of the following advantages:

1. **High Liquidity** – NIFTY 50 stocks are some of the most actively traded in the Indian market, which ensures smooth entry and exit without major slippage.
2. **Large-Cap and Stable** – These are well-established companies, so they generally avoid extreme price fluctuations seen in smaller-cap stocks.
3. **Diversification Across Sectors** – The NIFTY 50 represents multiple industries (IT, banking, energy, FMCG, etc.), which reduces concentration risk.
4. **Reliable Data Availability** – Historical and live market data for these stocks is easily accessible, making analysis and backtesting more accurate.
5. **Benchmark for Market Performance** – Since NIFTY 50 is the benchmark index of India, strategies tested on this universe have better relevance and comparability.
6. **Lower Impact Costs** – Due to high trading volumes, the cost of executing trades (impact cost) is relatively low.

3. Indicator-Based Trend Analysis

The main task in this process is to decide which indicators to use and how to interpret them. In my strategy, I combined classic indicators with custom ones:

- **ADX (Average Directional Index)** – Measures the strength of a trend. Higher values indicate a stronger trend.
- **RSI (Relative Strength Index)** – Identifies overbought (>70) or oversold (<30) conditions, signaling possible reversals.
- **MACD (Moving Average Convergence Divergence)** – Shows momentum and trend direction through the relationship of short- and long-term moving averages.
- **RS (Relative Strength)** – Evaluates how a stock has performed in the recent window using its gains and losses. Higher values show stronger performance, lower values show weaker performance.
- **ADX Slope** – Tracks the rate of change of ADX, helping to identify whether a trend is strengthening or weakening.
- **MACD Slope** – Monitors the steepness of MACD movement, giving early signals of increasing or decreasing momentum.

4. Generating Buy/Sell Signals

In this step, I focused on creating the signals that would later be used in backtesting. Before running actual backtests, it is difficult to know whether a signal works well or needs improvement. To address this, I designed four different methods of signal generation, each using different combinations of indicators. Each method had strengths and limitations.

To compare these methods, I ran random backtests on all of them and ranked their performance using metrics such as:

- **Sharpe Ratio – Risk-adjusted returns**
- **CAGR (Compound Annual Growth Rate) – Overall growth of the strategy**
- **Drawdown – Maximum loss from peak to trough**

The results were summarized in a ranking table where each row showed how often a strategy achieved a particular position across the metrics. Based on this, I was able to analyze which signals were more reliable and which ones could be discarded, always with clear reasoning behind the choice.

It is important to note that in strategy development, knowing why you reject certain approaches is just as important as knowing why you choose others.

SIGNAL 1

This method generates buy and sell signals using a combination of MACD, ADX, and DI indicators.

- A buy signal is generated when MACD is above its signal line, ADX is strong (>30), MACD is positive, and +DI is greater than –DI.
- A sell signal is generated when MACD is below its signal line, ADX is strong (>30), MACD is negative, and –DI is greater than +DI.
- An exit signal is triggered if the opposite MACD crossover occurs or if ADX weakens below 25.

This approach ensures that trades are taken only during strong trends and positions are exited when momentum weakens.

SIGNAL 2 – Adding RSI Filter

This method builds on Method 1 by adding RSI to avoid overbought or weak setups.

- Buy when Method 1's conditions are met and RSI < 70 (not overbought).
- Sell when Method 1's conditions are met and RSI > 40 (not oversold).
- Exit logic is the same as Method 1.
  This filter prevents chasing overextended moves and helps time entries more safely.

SIGNAL 3 – Adding ADX Slope and Combined Score

This method enhances Method 1 with ADX slope and a custom combined score to capture trend momentum.

- Buy when Method 1's conditions are met, ADX slope > 0 (trend strengthening), and Combined Score > 0.
- Sell when Method 1's conditions are met and ADX slope > 0.
- Exit logic is the same as Method 1.
  This approach emphasizes strengthening trends and aligns entries with improving momentum.

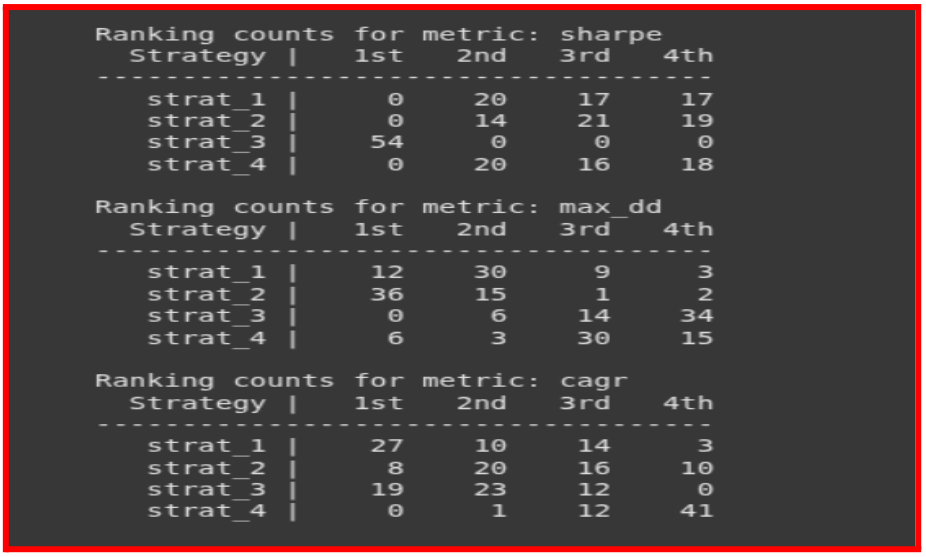
SIGNAL 4 – Combining RSI + ADX Slope

This method merges the RSI filter (Method 2) with the ADX slope condition (Method 3).

- Buy when Method 1's conditions are met, ADX slope > 0, and RSI < 70.
- Sell when Method 1's conditions are met, ADX slope > 0, and RSI > 40.
- Exit logic is the same as Method 1.
  This method is the most restrictive, combining momentum confirmation with protection from overbought/oversold traps.

RESULTS AND CAMPARISION OF SIGNALS AFTER BACKTESTING.

Each signal generation model was backtested across multiple stocks and time horizons, and their results were systematically compared. The evaluation focused on three key metrics:



```
Ranking counts for metric: sharpe
  Strategy |   1st   2nd   3rd   4th
-----------------------------------
   strat_1 |     0    20    17    17
   strat_2 |     0    14    21    19
   strat_3 |    54     0     0     0
   strat_4 |     0    20    16    18

Ranking counts for metric: max_dd
  Strategy |   1st   2nd   3rd   4th
-----------------------------------
   strat_1 |    12    30     9     3
   strat_2 |    36    15     1     2
   strat_3 |     0     6    14    34
   strat_4 |     6     3    30    15

Ranking counts for metric: cagr
  Strategy |   1st   2nd   3rd   4th
-----------------------------------
   strat_1 |    27    10    14     3
   strat_2 |     8    20    16    10
   strat_3 |    19    23    12     0
   strat_4 |     0     1    12    41
```

Criteria	***Strategy 1: Baseline (MACD + ADX + DI)***	***Strategy 2: RSI-Filtered Model***	***Strategy 3: ADX Slope + Composite Score***	***Strategy 4: Full Constraint Model***
Sharpe Ratio (Risk-Adjusted Return)	Moderate – mostly 2nd–3rd rank, rarely best	Average – consistent mid-ranks	**Outstanding – ranked 1st in all tests**	Weak – usually bottom half
Max Drawdown (Risk Control)	Strong – ranked top 2 in 42/54 cases	**Best – ranked 1st in 36 cases**	Weak – worst performer, 4th in 34 cases	Poor – often 3rd or 4th
CAGR (Growth Potential)	Fairly strong – 27 first-place finishes	Moderate – competitive but not dominant	Strong – 19 first-place finishes	**Weakest – 4th in 41 cases**
Strengths	Balanced, decent growth, good downside control	Excellent drawdown protection, filters false signals	**Unmatched Sharpe, strong CAGR potential**	Very strict filtering, avoids many false trades
Weaknesses	Rarely top in Sharpe, may miss strong alpha	Conservative – misses some big trends	**High drawdown risk, volatile**	Over-constrained, kills profitability
Best Use Case	**Balanced / Moderate Risk** strategy	**Risk-averse investors** prioritizing capital preservation	**Aggressive alpha seekers** with strong risk overlays (stop-loss, position caps)	Not recommended – overly strict, underperforms

Final Conclusion

- **Best Overall Performer:**
  Strategy 3 (ADX Slope + Composite Score) unmatched Sharpe Ratio, good CAGR. However, it carries significant drawdown risk, meaning it requires stop-loss integration and capital allocation discipline to be viable in real-world trading.
- **Safest Strategy (Defensive Choice):**
  Strategy 2 (RSI-Filtered Model) best at limiting drawdowns while still producing competitive growth. This is the most robust and risk-averse option, though less aggressive in alpha generation.
- **Balanced Middle Ground:**
  Strategy 1 (Baseline Model) provides decent CAGR and stable drawdown performance. A good compromise if one prefers simplicity.
- **Not Recommended:**
  Strategy 4 (Full Constraint Model) over-constrained, consistently underperforms in growth and drawdown.

5. Trade Execution Process

The strategy execution simulates how trades are actually taken, managed, and closed in a portfolio. It follows these main steps:

1. **Candidate Selection**
   - Each day, the strategy scans all stocks.
   - Stocks with a **buy signal** and a combined score are shortlisted as candidates.

$$\text{Combined Score}_t = 0.4 \cdot \text{EMA Score}_t + 0.3 \cdot \text{RS Score}_t + 0.3 \cdot \text{ADX Score}_t$$

2. **Weight Allocation**
   - Candidates are ranked by their scores.
   - The top *N* stocks (e.g., 10) are chosen.
   - Allocation is based on their scores, adjusted for **transaction cost (τ)** (0.1%) and **slippage cost (σ)** (0.05%).

$$w_i = \frac{S_i}{\sum_{j=1}^{N} S_j},$$

$$A_i = w_i \cdot C \cdot (1 - \tau - \sigma)$$

3. **Position Management**
   - If a stock is new, it is added with allocated capital at the current price.

- If it already exists in the portfolio, the position is averaged with the new allocation.
- Each position tracks: **allocation, entry price, and max price since entry**.

4. **Exit Rules**
   Positions are exited if:
   - An **exit signal** is generated, OR
   - Price falls below a **trailing stop-loss** (set at 10% below the max price).
   - On exit, funds are returned to cash after applying costs.
5. **Portfolio Tracking**
   - At the end of each day, the portfolio value = **cash + current positions value**.
   - This value is recorded daily to measure performance.

6. Obstacles, Pivots, and Learnings

1. No Overnight Short Positions in India:

The original idea was to run a long-short strategy. However, Indian regulations don't allow holding short positions overnight (except through the stock borrowing mechanism, which comes with high margin and borrowing costs).
Pivot: We shifted to a long-only strategy by picking filtered stocks and dropping the short side.
Drawback: This reduces hedging benefits, makes the strategy more exposed to market-wide downturns, and limits potential profits during bearish phases.

2. Survivorship Bias in Backtesting:
Using today's Nifty50 list for past data can be misleading, since many of those stocks were not part of the index earlier and only grew later to join. This creates survivorship bias.
Solution: We regularly updated the stock universe with historical index constituents using Wikipedia records (source). This ensured that backtesting reflects the actual stocks available at that time.

3. Accounting for Costs and Slippage:
PnL calculations without costs look great on paper, but in reality, transaction charges and slippages eat into returns. Especially in the cash segment, this can't be ignored.
Solution: After reviewing broker data, we assumed 0.1% as transaction costs (covering all charges) and 0.05% as slippage since we trade in highly liquid stocks. This adjustment makes results much closer to real-world execution. For further diving into the breakdowns you can refer to the below link: (source)

4. Buying After Close Price (Data & Execution Assumption):

Due to limited access to high-quality intraday historical data and computational constraints, we assumed that trades could be executed right after the day's close price. In reality, this is impossible since the market is closed.

Work-around: A practical solution in live trading is to fetch the price a couple of minutes before market close (e.g., 3:28 PM if the market closes at 3:30 PM) and treat that as the effective close. This gives a short buffer window to run computations, generate signals, and place orders.

Drawback: While the deviation from the actual close is usually small for liquid stocks, in high-volatility conditions, even this slight timing difference may impact execution quality and profitability.

7. Parameter Optimization and Backtesting

7.1 Importance of Parameter Tuning

Hyperparameter tuning is essential because the choice of parameters directly affects signals, trade frequency, and portfolio returns. The goal is not just to "fit the past" but to find robust settings that work across different market conditions. In trading, parameters fall into three groups:

- **Indicator settings** (e.g., EMA lengths, ADX or RSI periods).
- **Thresholds** (e.g., RSI overbought/oversold levels, ADX cutoffs, trailing stop %).
- **Portfolio rules** (e.g., number of stocks to hold, max holding period).

Not every parameter should be optimized blindly—some are based on financial reasoning, while others can be tuned systematically using grid search or rolling validation.

7.2 Parameter Tuning

For this strategy, I tested small ranges around standard indicator values:

- **MACD Long EMA**: 24–28
- **MACD Short EMA**: 11–15
- **Signal EMA**: 8–10
- **ADX Period**: 13–15
- **Number of Stocks**: 5, 10, 15

Since indicators need past data, a 3-month buffer was used before signals became valid.
The **Sharpe Ratio** was chosen as the optimization metric. The best parameter set with the highest Sharpe Ratio was stored.

7.3 Rolling Backtesting Framework

To avoid "cheating with future data," I used a rolling train-test design:

- **12-month training window** → find best parameters.
- **6-month test window** → apply parameters out-of-sample.
- Roll forward and repeat until the dataset ends.
- Each window also included a 3-month buffer for indicator initialization.

This process simulates real-world trading, ensures adaptability, and reduces overfitting. Portfolio performance was tracked and visualized through equity curves.

8. Pivot: Fixing Sideways and Downtrend Weakness

Even though my strategy was beating the index, I noticed two weak spots:

- **Downtrends:** As expected, the long-only system struggled since no shorts were taken.
- **Sideways markets:** This was surprising. The model kept picking small "fake" trends, which quickly reversed and hit stop-losses, pulling down the portfolio.

The Fix – Market Regime Filter: I added a Supertrend filter on NIFTY 50:

- No trades in downtrends or sideways phases.
- Strategy only trades in confirmed uptrends.

Benefits

1. Avoids big drawdowns during bad regimes.
2. Idle periods can be used to perform a mean-reversion strategy.
3. Makes the system more adaptable and reliable.

9. FINAL RESULTS AND ANALYSIS

Long-Only Strategy vs Market
The long-only strategy beats the market in most uptrend phases with higher CAGR and Sharpe ratios. It also limits drawdowns better during downturns, though it struggles in sideways periods. Overall, it delivers stronger returns than simply holding the index.

Market-Regime Strategy vs Market
The market-regime strategy is more consistent. It outperforms in uptrends, stays safe in sideways markets, and protects capital in downturns. This approach outperformed the market in 10 of 13 periods, making it the most reliable alpha generator.

For each of the 13 comparison windows you provided I compared these four metrics: **Sharpe (higher better), CAGR (higher), Max Drawdown (less negative = better), Total PnL (higher)**.
I report results in three ways: Sharpe-only, CAGR-only, Total-PnL-only, and a simple **majority-of-4-metrics** per window.

Results Final Strategy (out of 13 windows)

- Sharpe-only wins: 8 / 13
- CAGR-only wins: 10 / 13
- Total PnL wins: 10 / 13
- Majority-of-metrics wins (win if strategy is better on ≥3 of the 4 metrics): 10 / 13

Phase	Metric	Market (Benchmark)	Long-Only Strategy	Market-Regime Strategy
Uptrend	Sharpe Ratio	~1.6–3.2	2.3–4.0	3.0–3.4
	CAGR	~25–77%	70%+	86%+
	Max DD	–6% to –7%	–5% to –9%	–5% or less
Sideways	Sharpe Ratio	~0.8	~0.0 or negative	Flat / small +ve
	CAGR	Negative (–10% to –18%)	Negative / ~0	Flat / ~0
	Max DD	–13%+	–12%+	–8% to –10%
Downtrend	Sharpe Ratio	Negative	Negative	Less negative
	Max DD	–30% to –38%	–12% to –13%	–8% to –13%