Spot Price Bid Strategy Study

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Bidding Strategies - Fixed Bid

- Min: minimum price in the spot price history
- Min*1.25
- Max: maximum price in the spot price history
- On-demand: on-demand price
- On-demand x 4
- On-demand x 10: Maximum bid allowed
- On-demand x 0.25

Bidding Strategies - Dynamic

- Adaptive Algorithm:
  - Calculate the minimum price per ECU across all the instance types and availability zones
  - Calculate the bid: current price + error
  - If the bid exceed the threshold (2.1 * no_of_ECU *min_price_per_ECU), then bid with the minimum price in the spot history
- Adaptive Bid * 1.25
- Adaptive Market *1.25: when calculating the bid, no threshold is considered.

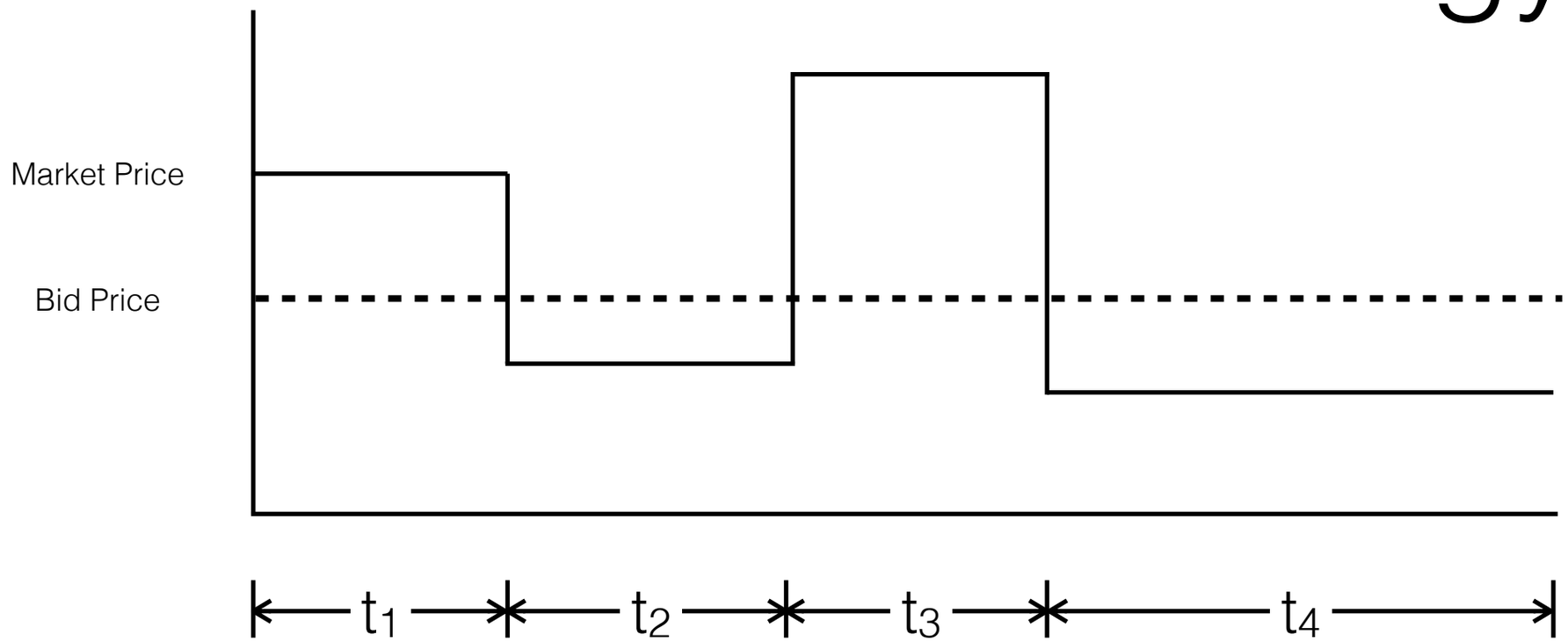
Bidding Strategies - Dynamic

- Optimal Algorithm:
  - Consider deadline
  - Use price PDF to calculate the bid
  - Bid price is calculated hourly, recursively calculated on deadline (bid price increases when approaching deadline)
  - Once the remaining execution equals to remaining deadline, use on-demand instances to execute the job
  - Assume checkpointing can be correctly performed and bid can be changed hourly

Simulation Setting

- Job execution time: 5, 10, 24, 100 hours
- Job deadline: 1 week (168 hours)
- Simulation frequency: 1 Hour (about 4-month period of real AWS spot price history, average 2500 rounds of simulation per instance type on one availability zone. Totally 81 sets of instance type and availability zone combination)

Simulation Methodology



Within one simulation (one week period):

- trying to bid every each hour if no instance is granted.
- If with a successful bid (at beginning of t2) a job cannot finish its execution (preempted by AWS due to price change), it is counted towards a fail execution.
- If with a successful bid, a job can finish its execution, but its finish time exceed deadline (one week from its first bid), it is counted towards a fail execution.
- If with a successful bid, a job can finish its execution, and its finish time is within deadline (one week from its first bid), it is counted towards a success execution.
- The simulation terminates when a job has a success execution or it reaches deadline (one week from its first bid)

Evaluation Criteria

- For one simulation *s:*
  - Immediate Start (*IS(s)), if an instance is granted at the first bid, IS(s)=1, otherwise, IS(s) =0*
  - *Fail Execution Set* $F(s) = \{b_1, \ldots, b_n\}$ *, each bid* $b_i(p_i, d_i)$ *is a 2-tuple, where* p_i *is the market price of the bid and* d_i *is the running time of the instance (in integral hour)*
  - *Success Execution Set S(s), S(s) is either an empty set or a set contain only one bid*
  - *Failure f(s): f(s) = 1 if IS(s) = 0 or |F(s)|>0, otherwise, f(s)=0*
  - *Deadline Miss d(s): d(s) =1 if |S(s)|=0, otherwise, d(s)=0*
  - *Cost C(s):* $C(s) = \sum_{i=1}^{|F(s)|} (p_i \times d_i | b_i \in F(s)) + \sum_{j=1}^{|S(s)|} (p_j \times d_j | b_j \in S(s))$

Evaluation Criteria

- For a set of simulation $Sim = \{s_1, \ldots, s_n\}$of an instance on one availability zone:

- Failure Rate: $\frac{\sum_{i=1}^{n} f(s_i)}{n}$

- Deadline Miss Rate: $\frac{\sum_{i=1}^{n} d(s_i)}{n}$

- Immediate Start Rate: $\frac{\sum_{i=1}^{n} IS(s_i)}{n}$

- Average Cost to Demand Rate: $\frac{\sum_{i=1}^{n} C(s_i)}{n \times (e \times p_d)}$, where *e* is the job execution time and p_d is the on-demand price

- Average Success Cost to Demand Rate: $\frac{\sum_{i=1}^{n} (C(s_i) \times (1 - d(s_i)))}{\sum_{i=1}^{n} (1 - d(s_i)) \times e \times p_d}$

Evaluation Criteria

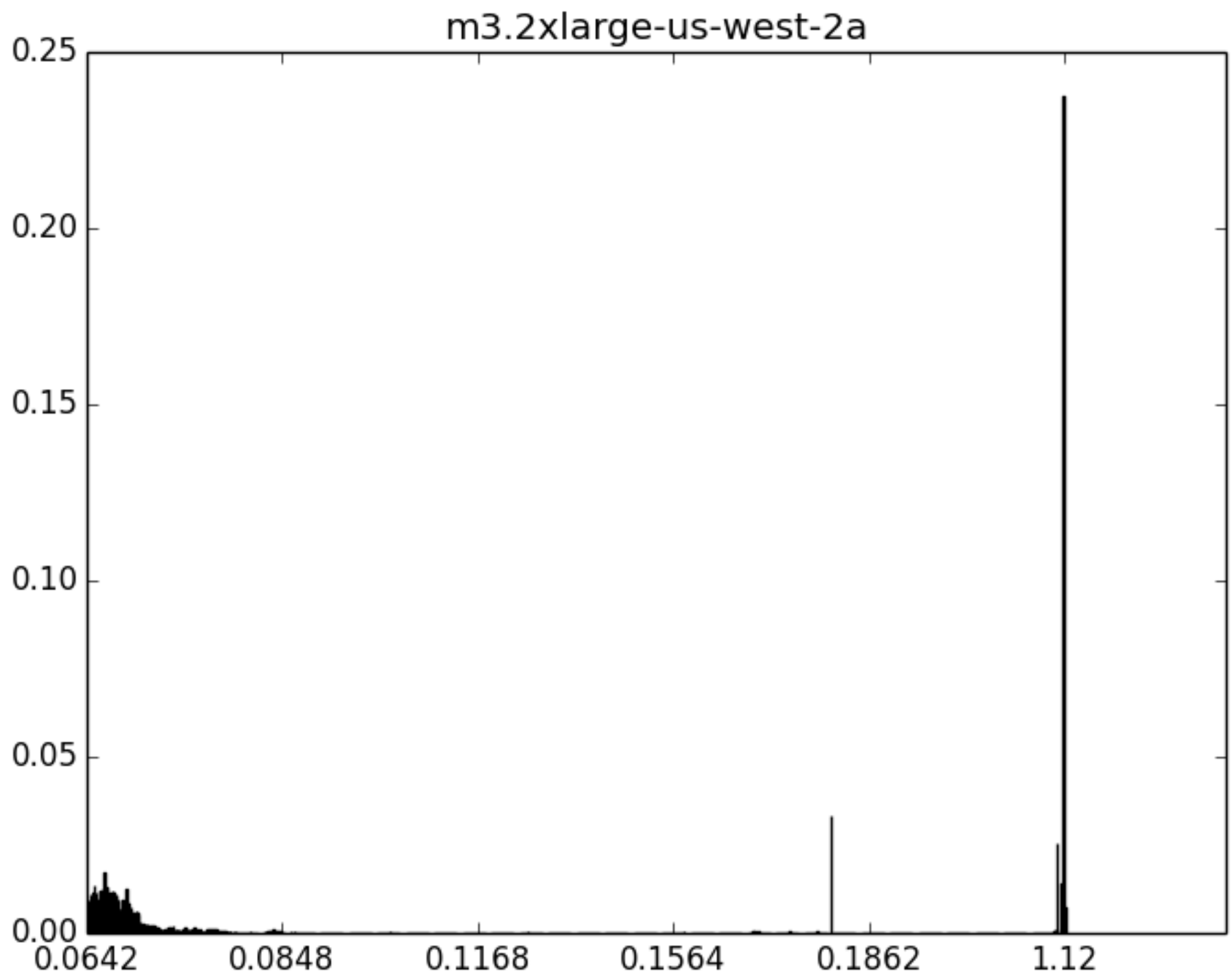
- Average Per Success Cost to Demand Rate:

$$\frac{\sum_{i=1}^{n} C(s_i)}{\sum_{i=1}^{n} (1 - d(s_i)) \times e \times p_d}$$

- Average Waiting Time for a Success Execution:

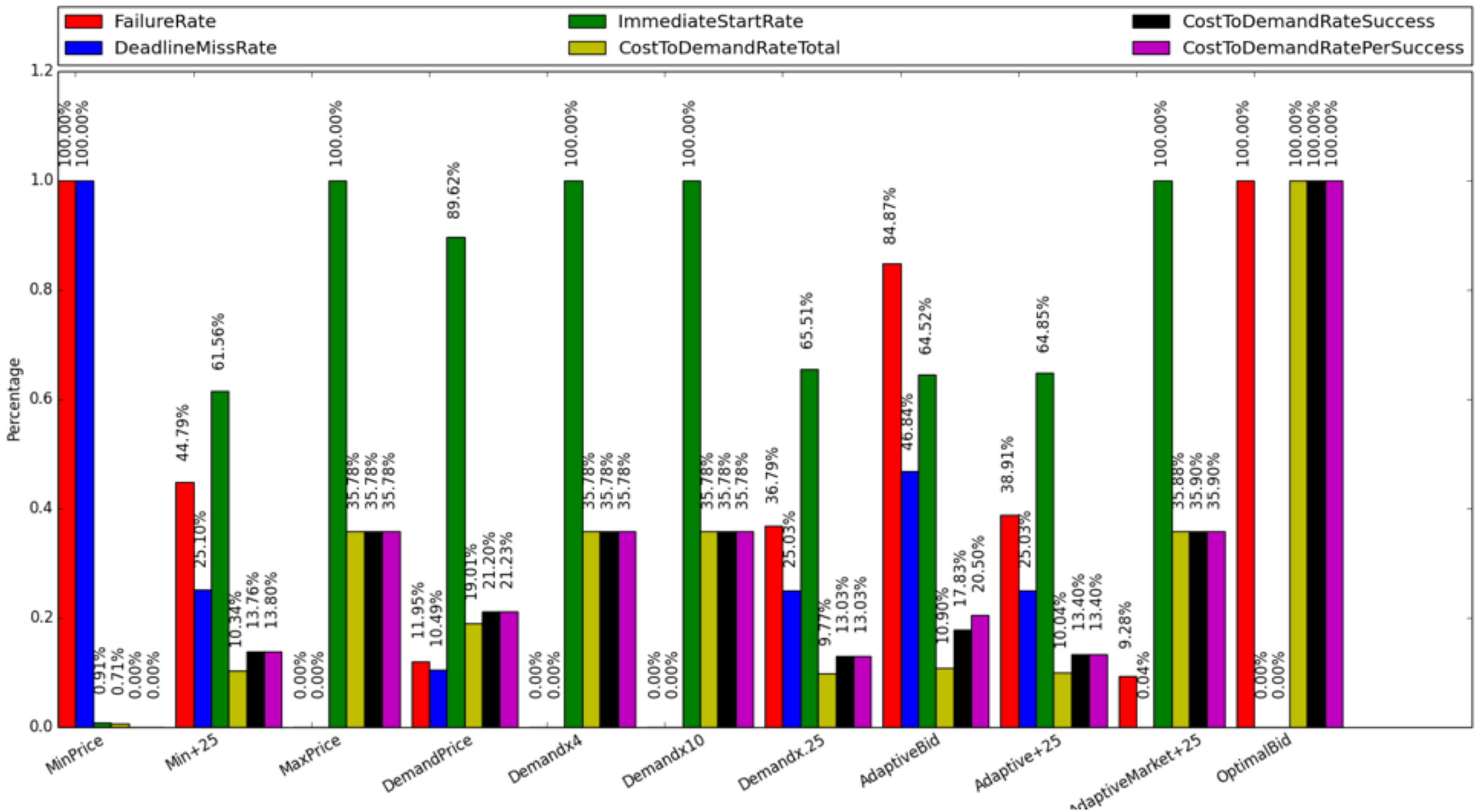
$$\frac{\sum_{i=1}^{n} (T_w(s_i) \times \frac{1}{1-D(Sim)} \times (1 - d(s_i))}{\sum_{i=1}^{n} (1 - d(s_i))}$$

- where $T_w(s_i)$ is the execution time for s_i, and D(Sim) is the deadline miss rate.

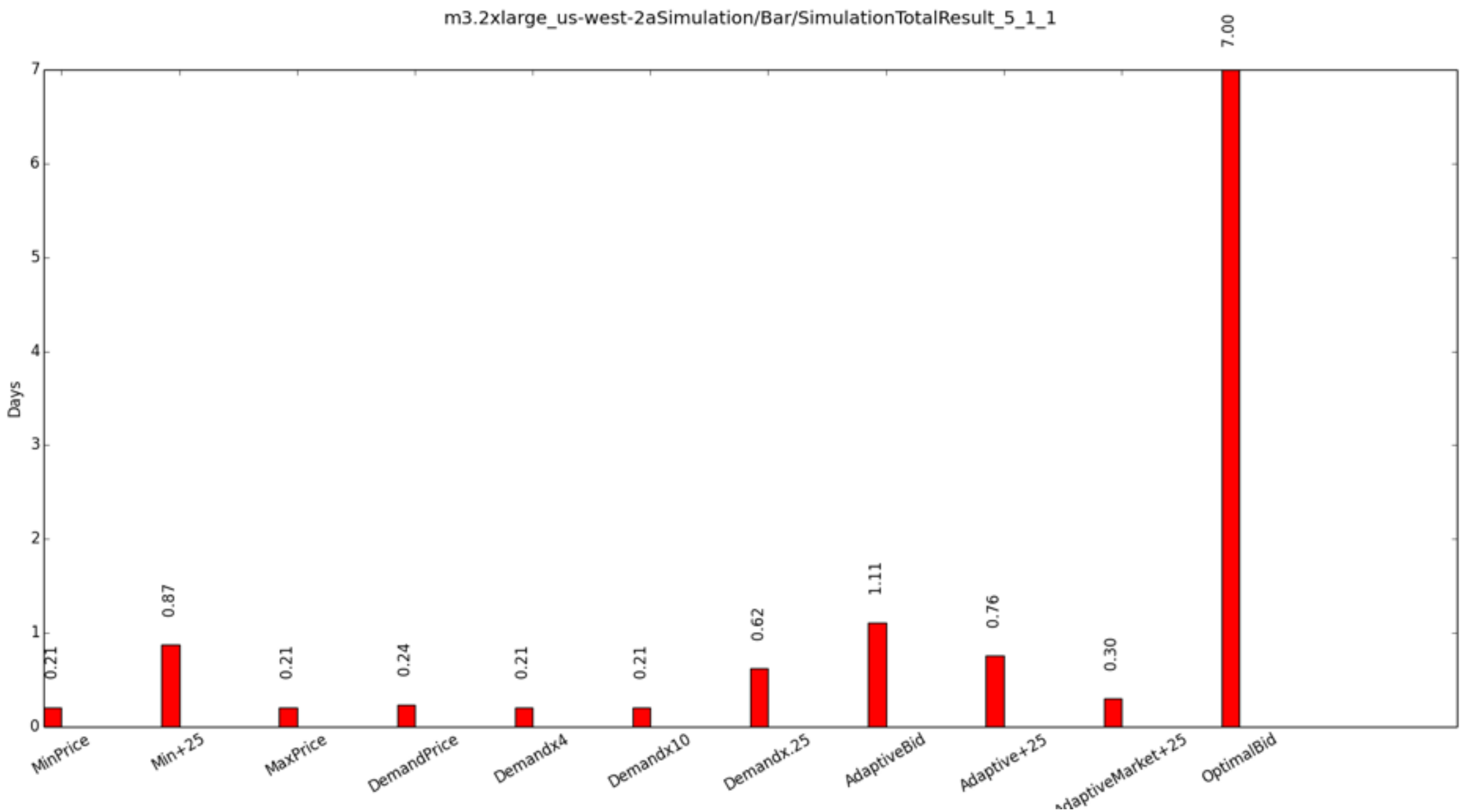


Price Distribution for m3.2xlarge in us-west-2a
(x-axis is not evenly distributed)

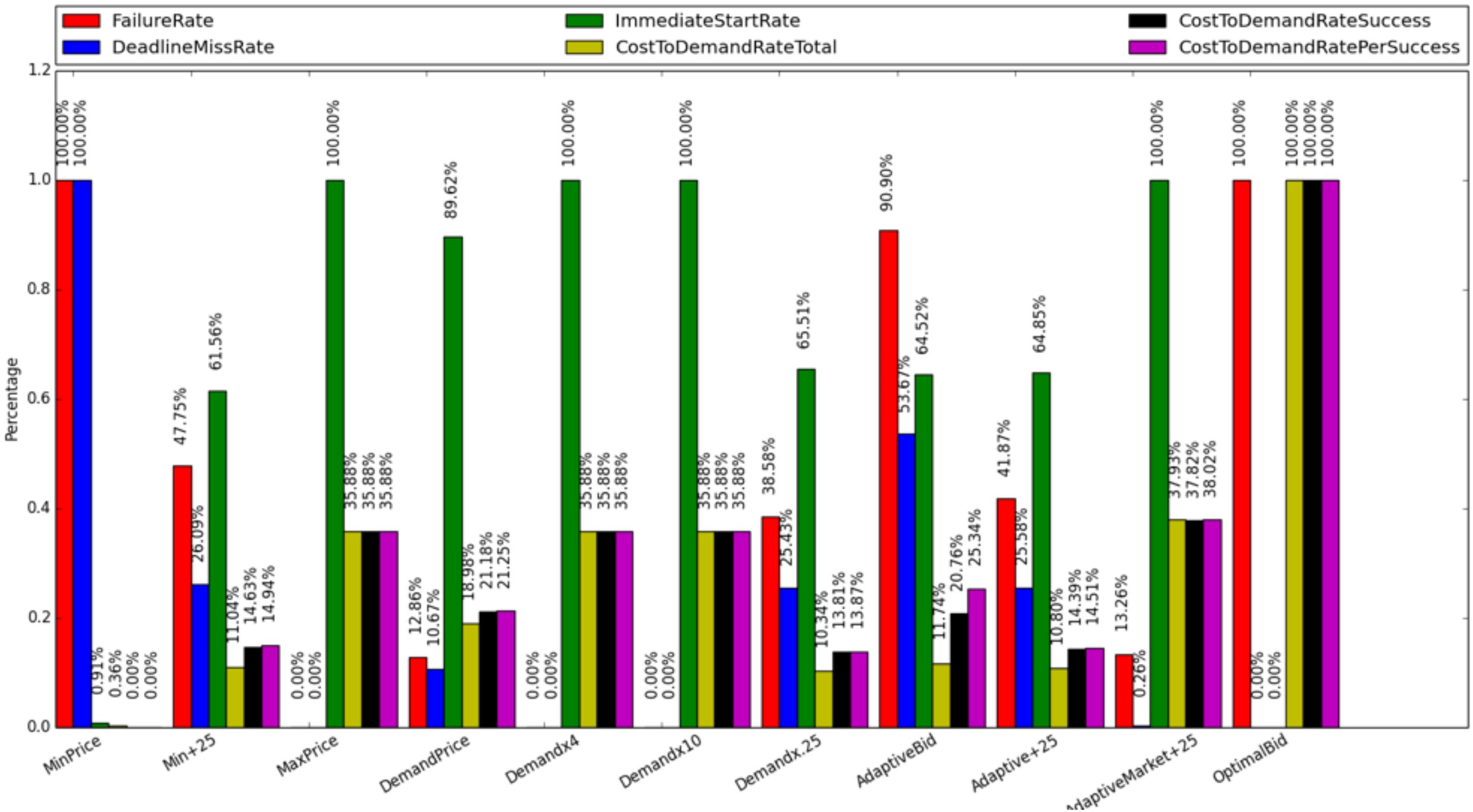
Simulation Results for 5-Hour Job



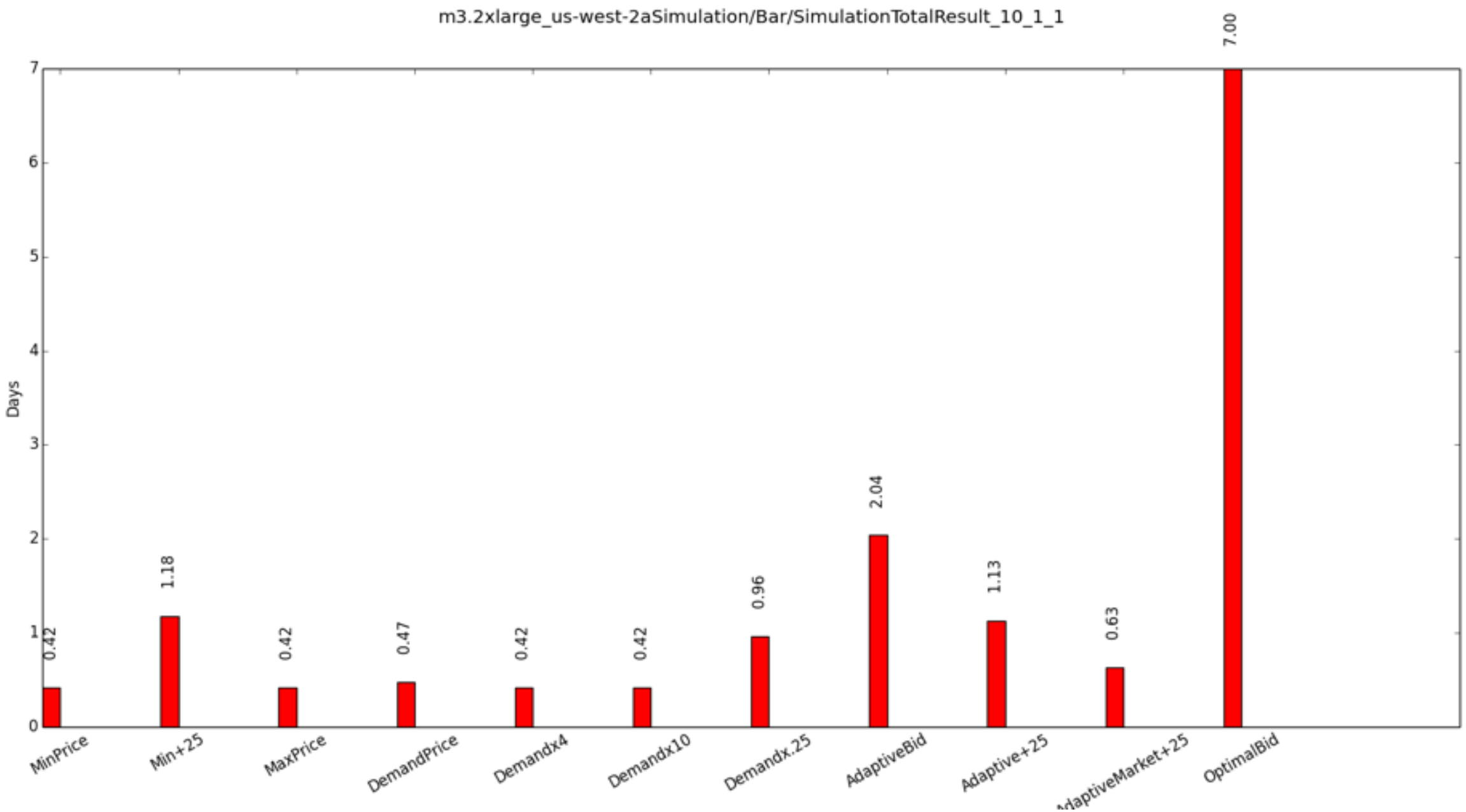
Average Execution Time for 5-Hour Job



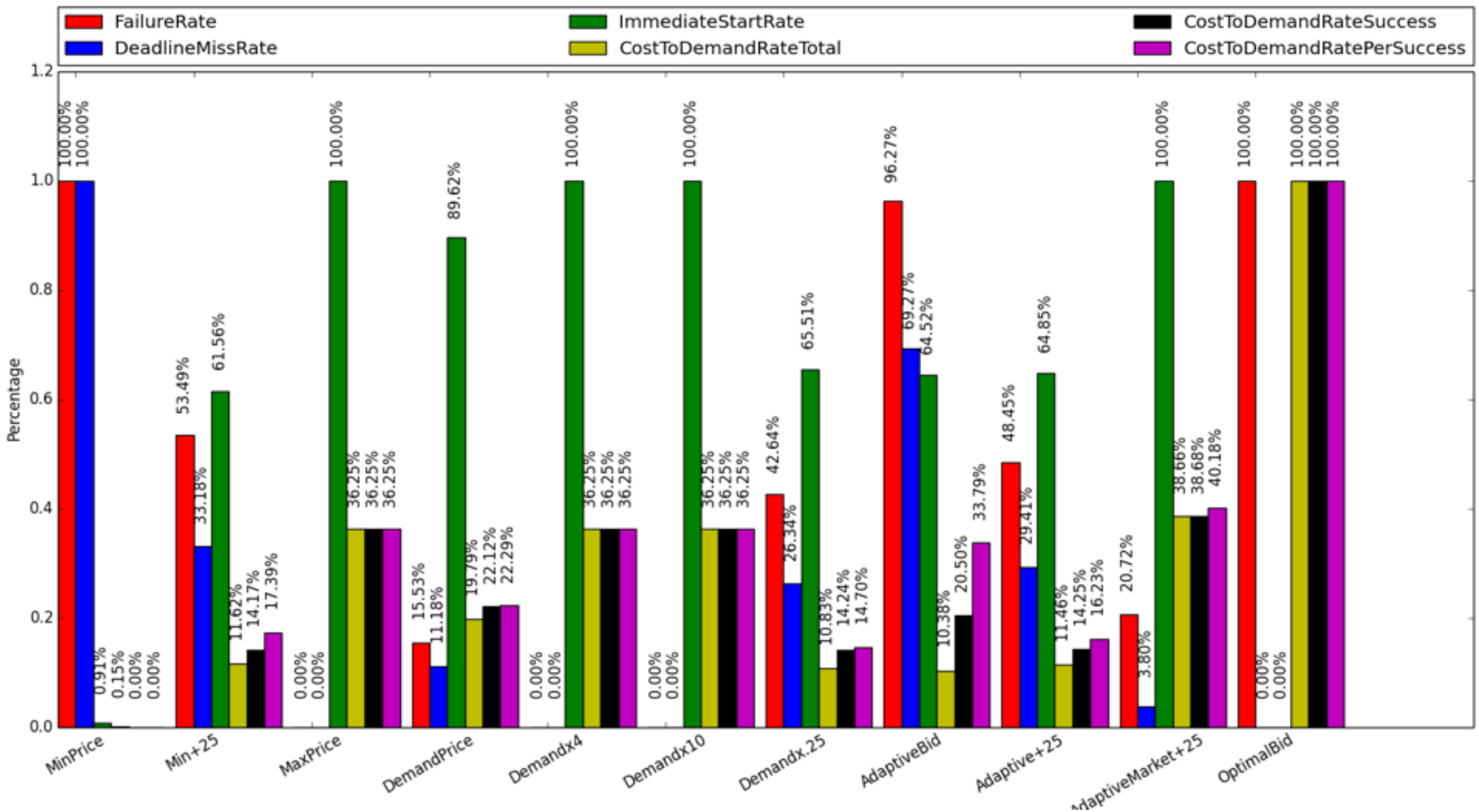
Simulation Results for 10-Hour Job



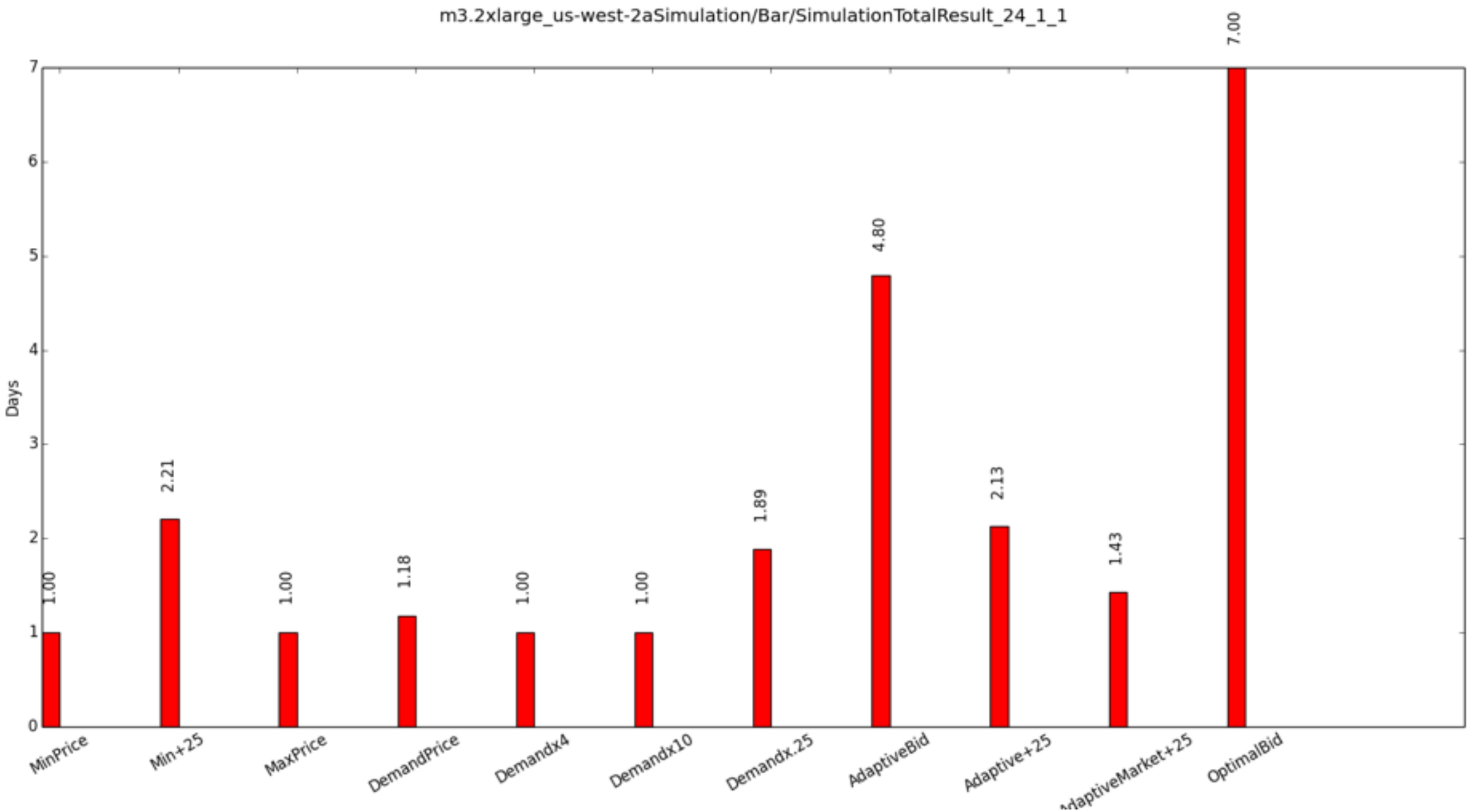
Average Execution Time for 10-Hour Job



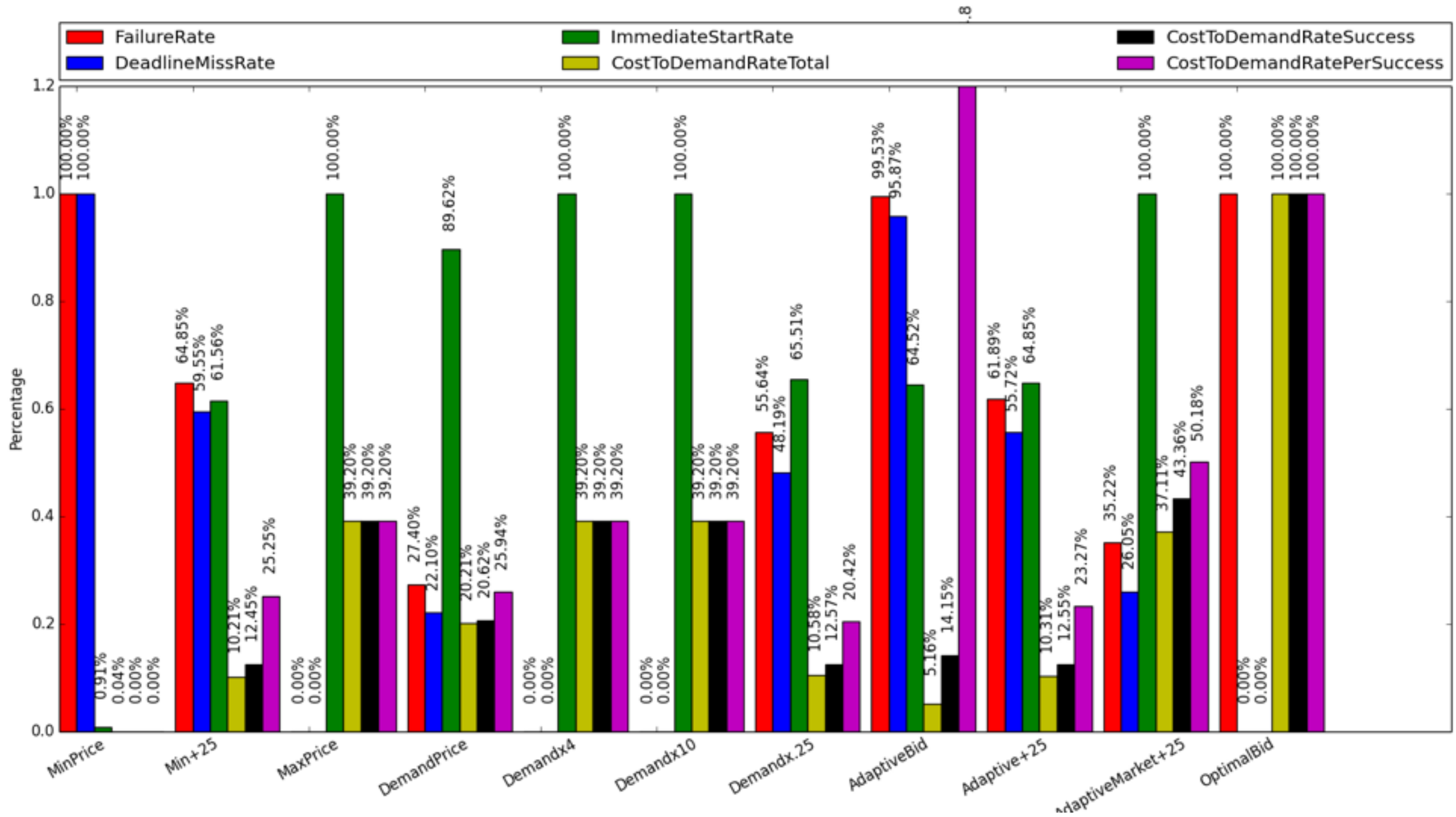
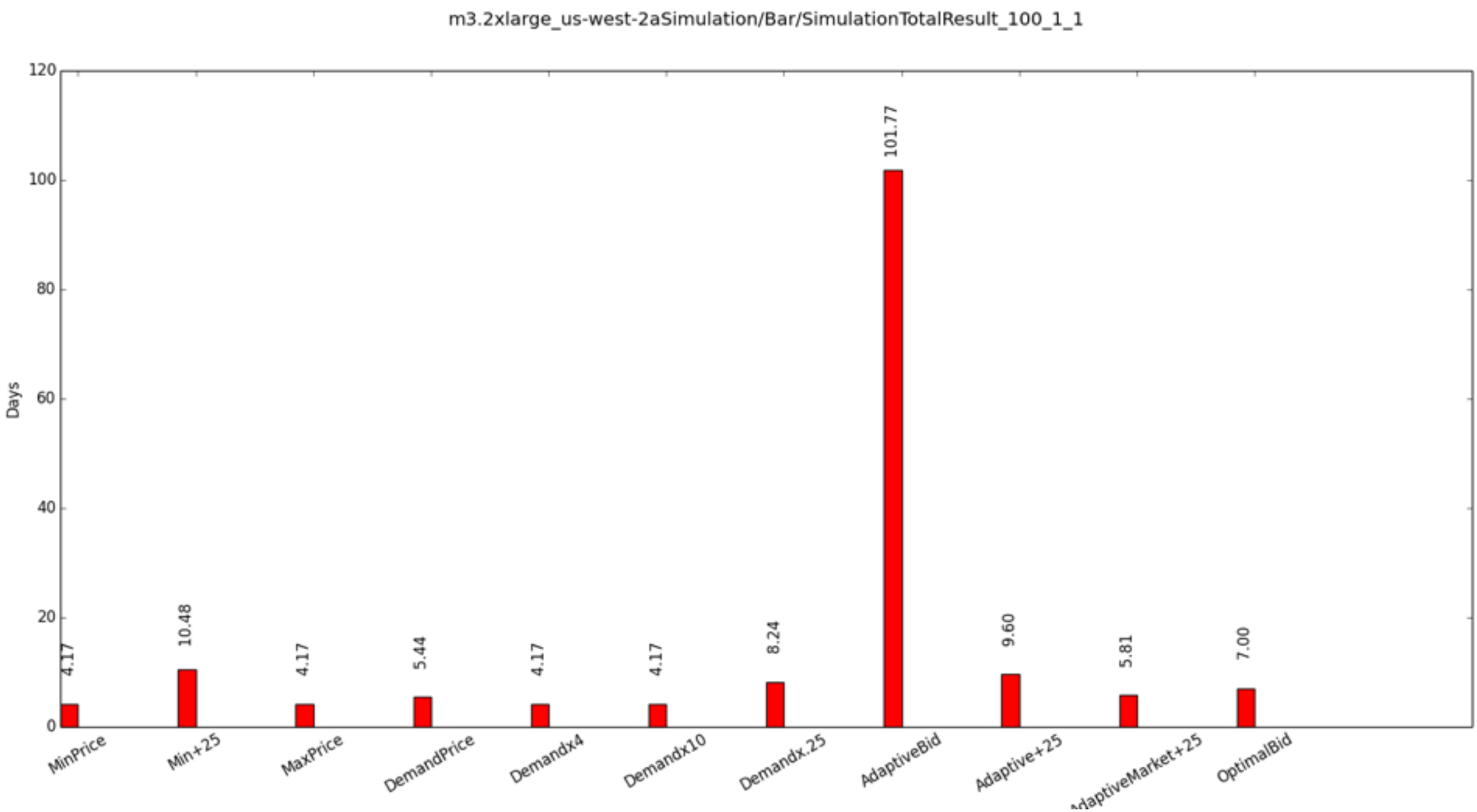
Simulation Results for 24-Hour Job



Average Execution Time for 24-Hour Job



Simulation Results for 100-Hour Job



Average Execution Time for 100-Hour Job