

Results

```
In [2]: import pandas as pd
import pickle
from prettytable import PrettyTable
from datetime import datetime
import re
import numpy as np
```

Results of Log Transformed data

```
In [3]: with open('./results_pickle/lstm_di_log.pkl', 'rb') as f:
        lstm_di_log = pickle.load(f)

with open('./results_pickle/SARIMAX_di_log.pkl', 'rb') as f:
    sarimax_di_log = pickle.load(f)

with open('./results_pickle/Exp_weight_avg_di_log.pkl', 'rb') as f:
    se_di_log = pickle.load(f)

with open('./results_pickle/holt_winters_di_log.pkl', 'rb') as f:
    hw_di_log = pickle.load(f)
```

```
In [4]: def compare_best(sari_di, hw_di, se_di, lstm_di):  
    '''  
        Compares the best model score and returns the best model for each unique combination  
    '''  
    print(compare_best.__doc__)  
    b_models = []  
    b_scores = []  
    f_names = []  
    for i in range(len(sari_di.values())):  
        f_names.append(list(sari_di.keys())[i])  
        ls = np.zeros(4)  
        ls[0] = list(sari_di.values())[i]  
        ls[1] = list(hw_di.values())[i]  
        ls[2] = list(se_di.values())[i]  
        ls[3] = list(lstm_di.values())[i]  
  
        if np.argmin(ls) == 0:  
            b_models.append('Sarimax')  
            b_scores.append(ls[0])  
        elif np.argmin(ls) == 1:  
            b_models.append('Holt-Winters')  
            b_scores.append(ls[1])  
        elif np.argmin(ls) == 2:  
            b_models.append('Exponential Weighted Average')  
            b_scores.append(ls[2])  
        else:  
            b_models.append('LSTM')  
            b_scores.append(ls[3])  
  
    return b_models, b_scores, f_names
```

```
In [5]: start = datetime.now()
best_models_log, best_scores_log, file_names_log = compare_best(sarimax_di_log, hw_di_log,
                                                                se_di_log, lstm_di_log)
print('\nTime taken: ', datetime.now() - start)
```

Compares the best model score and returns the best model for each unique combination

Time taken: 0:00:00.007019

```
In [6]: x = PrettyTable()

column_names = ["Name", "Best Model", "MAPE"]

x.add_column(column_names[0], file_names_log)
x.add_column(column_names[1], best_models_log)
x.add_column(column_names[2], best_scores_log)

print(x)
```

Name	Best Model	MAPE
APG ATLANTA_Oldcastle Retail CMP999820_EZ Mix.pkl	Exponential Weighted Average	5.314153841659752
Canada_Expocrete_Acheson.pkl	Sarimax	4.780319247573839
Canada_Expocrete_Balzac.pkl	Sarimax	3.4407645751395926
Canada_Expocrete_Edmonton.pkl	Exponential Weighted Average	1.991395027713599
Canada_Expocrete_Richmond.pkl	Sarimax	2.2510574146376503
Canada_Expocrete_Saskatoon.pkl	Exponential Weighted Average	14.16207765915776
Canada_Expocrete_Winnipeg.pkl	Sarimax	2.771846968958864
Canada_Permacon_Milton ON.pkl	Sarimax	3.1143712156669685
Canada_Permacon_Montreal QC.pkl	LSTM	5.375592566376957
Canada_Permacon_Woodstock Ontario.pkl	Sarimax	31.57087622881542
Central_Ash Grove MPC_Fort Smith, AR.pkl	Sarimax	1.7200142119421151
Central_Ash Grove MPC_Fremont, NE.pkl	Sarimax	2.1619898321908715
Central_Ash Grove MPC_Harrisonville, MO.pkl	Sarimax	2.145230315024334
Central_Ash Grove MPC_Jackson, MS.pkl	Exponential Weighted Average	3.6403674669256945
Central_Ash Grove MPC_Memphis, TN.pkl	Sarimax	2.142208238832877
Central_Ash Grove MPC_Muskogee, OK.pkl	Exponential Weighted Average	3.0170361254325018
Central_Ash Grove MPC_North Little Rock, AR.pkl	Sarimax	1.7636632678711037
Central_Ash Grove MPC_Oklahoma City, OK.pkl	Holt-Winters	2.1796319886108995
Central_Jewell_Austin TX (S).pkl	Exponential Weighted Average	2.271974899746169
Central_Jewell_Brittmoore.pkl	Sarimax	1.4690198955625173
Central_Jewell_Dallas TX (S).pkl	Exponential Weighted Average	1.3194466999526306
Central_Jewell_Frisco TX (S).pkl	Holt-Winters	1.5244961632034038
Central_Jewell_Houston TX - West Hardy (M).pkl	Holt-Winters	1.9374792475285956
Central_Jewell_Houston TX-N Garden.pkl	Exponential Weighted Average	1.1189297595001129
Central_Jewell_Hurst TX-SAK.pkl	Holt-Winters	1.0934353971450328
Central_Jewell_IBC TX-SAK.pkl	Sarimax	1.1233755845612257
Central_Jewell_Katy TX-SAK.pkl	Sarimax	1.2783954764055896
Central_Jewell_Keller TX (S).pkl	Holt-Winters	2.755405657626958
Central_Jewell_Marble Falls (SAK).pkl	Exponential Weighted Average	1.3737712779143458
Central_Jewell_Rosenberg TX.pkl	Sarimax	1.6877824011778002
Central_Jewell_Waco TX.pkl	Sarimax	1.8715323422050374
Central_Northfield_Bridgeport MI.pkl	LSTM	6.267926589901061
Central_Northfield_Cincinnati OH-SAK.pkl	LSTM	1.2791445840056972
Central_Northfield_Forest View IL.pkl	LSTM	2.4698562893767746
Central_Northfield_Franklin Park IL-SAK.pkl	LSTM	1.2235364580366024
Central_Northfield_Indianapolis IN.pkl	Sarimax	2.1108654104162192
Central_Northfield_Miller Materials KC Plant.pkl	Sarimax	2.375126052464595
Central_Northfield_Miller MaterialsBonner Springs.pkl	Sarimax	2.364994207397047

Central_Northfield_Morris IL.pkl	Sarimax	1.8791494138406049
Central_Northfield_Mundelein IL.pkl	Sarimax	2.52853624686265
Central_Northfield_Shakopee.pkl	Sarimax	3.774556240407539
Central_Northfield_Sheffield OH.pkl	Sarimax	2.9455682290521294
Central_Northfield_West Des Moines IA.pkl	Sarimax	1.76222736544945
Central_Northfield_Wisconsin Distribution Yard.pkl	Sarimax	5.026637171612148
East_Adams_Products_Anderson SC.pkl	Holt-Winters	2.37130578687455
East_Adams_Products_Ashville NC.pkl	Sarimax	1.7484653189151471
East_Adams_Products_Charlotte NC Plant.pkl	Holt-Winters	1.3129057306717744
East_Adams_Products_Charlotte NC.pkl	LSTM	1.51000999647456
East_Adams_Products_Clarksville TN.pkl	LSTM	1.629907685078737
East_Adams_Products_Colfax NC.pkl	Sarimax	1.6163756588764184
East_Adams_Products_Cowpens SC.pkl	Sarimax	2.012271708431551
East_Adams_Products_Dunn NC.pkl	Exponential Weighted Average	1.2981720655395443
East_Adams_Products_Durham NC.pkl	Holt-Winters	2.270447393674892
East_Adams_Products_Fayetteville NC.pkl	Holt-Winters	2.1720839553934104
East_Adams_Products_Franklin NC.pkl	LSTM	1.424433765271397
East_Adams_Products_Franklin TN-SAK.pkl	LSTM	1.3754190629005374
East_Adams_Products_Goldsboro NC.pkl	Exponential Weighted Average	2.8366480485695256
East_Adams_Products_Greensboro NC.pkl	Sarimax	1.7716797048850454
East_Adams_Products_Greenville NC.pkl	Holt-Winters	1.9107543567407916
East_Adams_Products_Greenville SC.pkl	LSTM	1.627094957866457
East_Adams_Products_Hickory NC.pkl	Holt-Winters	1.869105904298283
East_Adams_Products_HollyHill SC.pkl	Exponential Weighted Average	1.8725214272494781
East_Adams_Products_Inman SC.pkl	Exponential Weighted Average	1.4294861346718903
East_Adams_Products_Jacksonville NC.pkl	Holt-Winters	1.5551525554287609
East_Adams_Products_Lilesville NC-SAK.pkl	LSTM	1.161121748387979
East_Adams_Products_Morehead NC.pkl	Holt-Winters	1.9680980452980044
East_Adams_Products_Morrisville NC.pkl	LSTM	1.1001355762899963
East_Adams_Products_Myrtle Beach SC.pkl	Sarimax	1.6344985331069335
East_Adams_Products_Nashville TN.pkl	Holt-Winters	3.7584217433837366
East_Adams_Products_Rockwood TN.pkl	Sarimax	1.7216049201703874
East_Adams_Products_Rocky Mount NC.pkl	Sarimax	1.8877476598566825
East_Adams_Products_Stallings NC.pkl	Exponential Weighted Average	3.3389383572697917
East_Adams_Products_Wilmington NC.pkl	Exponential Weighted Average	2.127484306623306
East_Adams_Products_Youngsville NC.pkl	LSTM	1.390912373663109
East_Anchor_Anchor South Region.pkl	Exponential Weighted Average	10.566363383559315
East_Anchor_Batavia NY-SAK.pkl	LSTM	1.451940726639264
East_Anchor_Brick NJ.pkl	Exponential Weighted Average	2.1191627888122255
East_Anchor_Bristol PA-SAK.pkl	LSTM	1.5856898527604608
East_Anchor_Calverton NY-SAK.pkl	LSTM	1.4752221067622329
East_Anchor_Canaan CT-SAK.pkl	LSTM	0.9133103825690279

East_Anchor_Cranston RI.pkl	Sarimax	1.9577233115208845
East_Anchor_Crofton MD.pkl	Sarimax	2.018957314975493
East_Anchor_East Petersburg PA.pkl	Sarimax	1.7359735313599751
East_Anchor_Easton PA.pkl	Sarimax	2.90451171597774
East_Anchor_Emigsville PA.pkl	Holt-Winters	1.9516969684221261
East_Anchor_Farmingdale NJ.pkl	Sarimax	2.6225277700465663
East_Anchor_Fishers NY.pkl	LSTM	2.1050759663401584
East_Anchor_Fredonia PA-SAK.pkl	Sarimax	1.9504286725240456
East_Anchor_Holbrook MA.pkl	Sarimax	2.322498510925735
East_Anchor_Keene NH.pkl	Sarimax	3.5693742306937963
East_Anchor_Lebanon NH.pkl	Sarimax	2.0484114934655686
East_Anchor_Lyndhurst NJ.pkl	Exponential Weighted Average	3.6034294175061916
East_Anchor_Milford VA-SAK.pkl	LSTM	1.3416324374995194
East_Anchor_Oxford MA-SAK.pkl	LSTM	1.758702065959847
East_Anchor_White Marsh MD-SAK.pkl	Sarimax	1.2975448261797935
East_Anchor_Winchester VA.pkl	LSTM	1.5158459571022542
East_Georgia Masonry Supply_Cartersville GA BLOCK.pkl	Holt-Winters	1.6632653478895272
East_Georgia Masonry Supply_Conley GA-SAK.pkl	Sarimax	1.1835414783151035
East_Georgia Masonry Supply_Florence AL.pkl	Sarimax	2.1929006869647085
East_Georgia Masonry Supply_Jasper AL.pkl	Holt-Winters	12.744742498393794
East_Georgia Masonry Supply_Jonesboro GA.pkl	Sarimax	1.4721056452115162
East_Georgia Masonry Supply_Lawrenceville GA DIST.pkl	Sarimax	1.4514417360059708
East_Georgia Masonry Supply_Lawrenceville GA MANF.pkl	Exponential Weighted Average	1.9218196171019577
East_Georgia Masonry Supply_Macon GA.pkl	Sarimax	1.5679352519727328
East_Georgia Masonry Supply_Montgomery AL.pkl	Exponential Weighted Average	2.364615618216656
East_Georgia Masonry Supply_Pelham AL.pkl	LSTM	1.855514485937065
East_Georgia Masonry Supply_Tyrone GA.pkl	LSTM	1.4536635795623756
East_OldcastleCoastal_Auburndale FL-SAK.pkl	Holt-Winters	1.1325562087456933
East_OldcastleCoastal_Defuniak.pkl	Holt-Winters	1.4722701636516666
East_OldcastleCoastal_Fort Myers FL.pkl	Exponential Weighted Average	1.7955257556573896
East_OldcastleCoastal_Fort Pierce FL.pkl	Sarimax	1.7402464558278394
East_OldcastleCoastal_Gainesville FL.pkl	LSTM	1.7121015577986378
East_OldcastleCoastal_Gulfport MS.pkl	LSTM	2.198668341464816
East_OldcastleCoastal_Haines City FL Hardscapes.pkl	Holt-Winters	0.8986031602249684
East_OldcastleCoastal_Jacksonville FL-SAK.pkl	Sarimax	1.329983848861221
East_OldcastleCoastal_Jacksonville FL.pkl	Sarimax	1.3425075345659694
East_OldcastleCoastal_Lehigh Acres FL.pkl	Sarimax	1.875982722989825
East_OldcastleCoastal_Longwood FL.pkl	Exponential Weighted Average	1.4317259390917412
East_OldcastleCoastal_Orlando FL.pkl	Sarimax	0.9178946332401242
East_OldcastleCoastal_Pensacola FL-SAK.pkl	Sarimax	1.6811230159720507
East_OldcastleCoastal_Pompano FL Hardscapes.pkl	Sarimax	1.3518633375080726
East_OldcastleCoastal_Pompano FL-SAK.pkl	Sarimax	0.889967962385461

East_OldcastleCoastal_Sarasota FL.pkl	Sarimax	1.12169778898559
East_OldcastleCoastal_Tampa FL - Anderson Rd.pkl	Sarimax	1.1127140759599328
East_OldcastleCoastal_Tampa FL - Busch Blvd.pkl	Exponential Weighted Average	1.3061543654248913
East_OldcastleCoastal_Tampa FL-SAK.pkl	Holt-Winters	1.0574612892254291
East_OldcastleCoastal_Theodore AL.pkl	Holt-Winters	2.53978653956751
East_OldcastleCoastal_West Palm Beach FL.pkl	Holt-Winters	0.8398642010953772
East_OldcastleCoastal_Zephyrhills FL.pkl	Sarimax	1.3301865798876182
Lawn and Garden_L&G Central_Aliceville AL.pkl	Exponential Weighted Average	8.588007393377156
Lawn and Garden_L&G Central_Amherst Junction WI.pkl	LSTM	2.910586683616632
Lawn and Garden_L&G Central_Bridgeport MI.pkl	LSTM	9.705544191983433
Lawn and Garden_L&G Central_Cleveland, TX.pkl	LSTM	2.2804321157915313
Lawn and Garden_L&G Central_Dallas TX.pkl	Sarimax	2.440578993948743
Lawn and Garden_L&G Central_Del Valle, TX.pkl	LSTM	3.3176018667292793
Lawn and Garden_L&G Central_Harrah OK.pkl	LSTM	3.2883109370573815
Lawn and Garden_L&G Central_Hope AR.pkl	LSTM	1.606890085700167
Lawn and Garden_L&G Central_Livingston TX.pkl	Sarimax	1.958513737043142
Lawn and Garden_L&G Central_Marseilles IL.pkl	LSTM	2.4746540429685897
Lawn and Garden_L&G Central_Miami OK.pkl	LSTM	2.5649318420235687
Lawn and Garden_L&G Central_Paola KS.pkl	Sarimax	4.683758679781783
Lawn and Garden_L&G Central_Powderly TX.pkl	LSTM	2.8828720336468923
Lawn and Garden_L&G Central_Sauget IL.pkl	Sarimax	3.2171214460909723
Lawn and Garden_L&G Central_Tulia TX.pkl	Sarimax	7.655064280557737
Lawn and Garden_L&G Central_Tylertown MS.pkl	Sarimax	2.589973563848342
Lawn and Garden_L&G Central_Waterloo IN.pkl	LSTM	3.520362956158099
Lawn and Garden_L&G Northeast_Berlin NY.pkl	Sarimax	8.620563418283233
Lawn and Garden_L&G Northeast_Carey OH.pkl	Exponential Weighted Average	4.496259023014833
Lawn and Garden_L&G Northeast_Castlewood VA.pkl	Sarimax	2.5014954147456505
Lawn and Garden_L&G Northeast_Chatsworth GA.pkl	Sarimax	3.0471306730560372
Lawn and Garden_L&G Northeast_Historical-Co-Packer.pkl	LSTM	20.524461296501535
Lawn and Garden_L&G Northeast_Hooksett NH.pkl	Sarimax	4.798211834761299
Lawn and Garden_L&G Northeast_Lee MA.pkl	Sarimax	2.409644272715557
Lawn and Garden_L&G Northeast_Manchester NY.pkl	Exponential Weighted Average	14.146939991044821
Lawn and Garden_L&G Northeast_Mount Hope NJ.pkl	LSTM	1.8576014125912614
Lawn and Garden_L&G Northeast_Poland Spring ME.pkl	Sarimax	5.320320415299232
Lawn and Garden_L&G Northeast_Quakertown PA.pkl	Sarimax	4.800649753317508
Lawn and Garden_L&G Northeast_Thomasville PA.pkl	Sarimax	2.0536036872658983
Lawn and Garden_L&G Northeast_Wyoming RI.pkl	Sarimax	5.651111943365099
Lawn and Garden_L&G Southeast_Aberdeen NC.pkl	Sarimax	2.6766107910362456
Lawn and Garden_L&G Southeast_Bostwick FL.pkl	Sarimax	3.0293355195787917
Lawn and Garden_L&G Southeast_Cross City FL.pkl	Sarimax	2.221612086000611
Lawn and Garden_L&G Southeast_Davenport FL.pkl	Exponential Weighted Average	2.240506443862894
Lawn and Garden_L&G Southeast_Fort Green FL.pkl	LSTM	2.3889451919945213

Lawn and Garden_L&G Southeast_Gaffney SC.pkl	LSTM	2.2803481488775406
Lawn and Garden_L&G Southeast_Louisburg NC.pkl	LSTM	2.3857531039749014
Lawn and Garden_L&G Southeast_Moore Haven FL.pkl	Sarimax	2.1039789718999318
Lawn and Garden_L&G Southeast_Pageland SC.pkl	Sarimax	2.199579768094937
Lawn and Garden_L&G Southeast_Shady Dale GA.pkl	Sarimax	2.5802948056053547
Lawn and Garden_L&G Southeast_Walterboro SC.pkl	Sarimax	2.7899658836484806
National_AMTC_Saint Paul MN.pkl	Exponential Weighted Average	3.932416202302284
National_Anchor Wall Systems_Minnetonka MN.pkl	Sarimax	2.2286262274647193
National_MoistureShield_Lowell AR.pkl	LSTM	2.452122990211984
National_MoistureShield_Springdale AR.pkl	Exponential Weighted Average	1.5572749110180906
National_Oldcastle Sakerete Billing_Easy Mix.pkl	Sarimax	4.977366769776699
National_Oldcastle Sakerete Billing_Roberts Concrete.pkl	Sarimax	6.347222071147277
National_Oldcastle Sakerete Billing_US Mix.pkl	Sarimax	1.7879589594556002
National_Techniseal_Ash Grove Memphis.pkl	Exponential Weighted Average	5.222541129353486
National_Techniseal_Ash Grove Nebraska.pkl	LSTM	4.427190942433016
National_Techniseal_Candiac.pkl	LSTM	3.478638160502194
National_Techniseal_Coastal Tampa.pkl	Exponential Weighted Average	10.975614109963058
National_Techniseal_CPM Portland.pkl	LSTM	6.25033699366245
National_Techniseal_Ectra.pkl	Sarimax	20.596614747452517
National_Techniseal_Eurl Leps Mehat.pkl	Exponential Weighted Average	10.84836291285565
National_Techniseal_EZ Mix.pkl	Exponential Weighted Average	4.951231733470895
National_Techniseal_Handy Concrete.pkl	Exponential Weighted Average	5.550416720015288
National_Techniseal_PTB Compaktuna.pkl	Holt-Winters	6.423383676002453
National_Techniseal_Ras.pkl	Sarimax	8.248179271272397
National_Techniseal_Techmix.pkl	Sarimax	3.4248718455920106
National_Westtile_Westtile Roofing Products.pkl	Sarimax	1.5614617637754675
West_Amcor_North Salt Lake UT.pkl	Sarimax	2.5473586840633002
West_CPM_Frederickson, WA.pkl	Holt-Winters	4.1144604354368886
West_CPM_Kent, WA.pkl	Sarimax	1.4465102559961787
West_CPM_Northstar Consignment.pkl	Exponential Weighted Average	7.94673612576838
West_CPM_Pasco WA.pkl	Exponential Weighted Average	3.56483360422325
West_CPM_Portland, OR.pkl	Sarimax	1.3589922981922657
West_CPM_Spokane, WA.pkl	Sarimax	2.023427876671506
West_Sierra_Fontana CA.pkl	Holt-Winters	1.3884545708867593
West_Sierra_Reno NV.pkl	Sarimax	2.0819223862516245
West_Sierra_San Carlos CA.pkl	Sarimax	6.1647164907965335
West_Sierra_Stockton CA.pkl	Sarimax	1.2164440508316785
West_Superlite_Gilbert, AZ.pkl	Sarimax	1.8337850220912197
West_Superlite_Integra Product.pkl	Holt-Winters	4.915487940254884
West_Superlite_Lone Butte.pkl	Sarimax	1.6445992780422056
West_Superlite_North Las Vegas.pkl	Sarimax	1.647633630484574
West_Superlite_Superlite - Western 19th Ave.pkl	Exponential Weighted Average	1.425847769833303

West_Superlite_Tucson, AZ - Gardner Ln.pkl	Holt-Winters	1.2345407775132053
West_Superlite_West Phoenix N. 42nd Ave, AZ.pkl	Exponential Weighted Average	0.8849324247526559
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Count of each Best Model on Log Transformed Data

```
In [7]: lstm = 0
sari = 0
hw = 0
se = 0
for i in best_models_log:
    if i == 'LSTM':
        lstm += 1
    elif i == 'Sarimax':
        sari += 1
    elif i == 'Holt-Winters':
        hw += 1
    else:
        se += 1

print('Number of LSTM Best models: ', lstm)
print('Number of Holt-Winters Best models: ', hw)
print('Number of Sarimax Best models: ', sari)
print('Number of Exponential Weighted Avg Best models: ', se)
```

```
Number of LSTM Best models: 44
Number of Holt-Winters Best models: 28
Number of Sarimax Best models: 98
Number of Exponential Weighted Avg Best models: 38
```

```
In [9]: print('Lower bound of results: ', np.min(best_scores_log))
print('Upper bound of results: ', np.max(best_scores_log))
```

```
Lower bound of results: 0.8398642010953772
Upper bound of results: 31.57087622881542
```

Results for Differenced Data

```
In [10]: with open('./results_pickle/SARIMAX_di.pkl', 'rb') as f:
          sarimax_di = pickle.load(f)

          with open('./results_pickle/Exponential_weighted_avg_di.pkl', 'rb') as f:
              se_di = pickle.load(f)

          with open('./results_pickle/Holts-Winters_di.pkl', 'rb') as f:
              hw_di = pickle.load(f)
```

```
In [11]: def compare_best_diff(sari_di, hw_di, se_di):
          """
          Compares the best model score and returns the best model for each unique combination
          """
          print(compare_best.__doc__)
          b_models = []
          b_scores = []
          f_names = []
          for i in range(len(sari_di.values())):
              f_names.append(list(sari_di.keys())[i])
              ls = np.zeros(3)
              ls[0] = list(sari_di.values())[i]
              ls[1] = list(hw_di.values())[i]
              ls[2] = list(se_di.values())[i]

              if np.argmin(ls) == 0:
                  b_models.append('Sarimax')
                  b_scores.append(ls[0])
              elif np.argmin(ls) == 1:
                  b_models.append('Holt-Winters')
                  b_scores.append(ls[1])
              else:
                  b_models.append('Exponential Weighted Average')
                  b_scores.append(ls[2])

          return b_models, b_scores, f_names
```

```
In [12]: start = datetime.now()
best_models, best_scores, file_names = compare_best_diff(sarimax_di, hw_di, se_di)
print('\nTime taken: ', datetime.now() - start)
```

Compares the best model score and returns the best model for each unique combination

Time taken: 0:00:00.011985

```
In [13]: x = PrettyTable()

column_names = ["Name", "Best Model", "MAPE"]

x.add_column(column_names[0], file_names)
x.add_column(column_names[1], best_models)
x.add_column(column_names[2], best_scores)

print(x)
```

Name	Best Model	MAPE
APG ATLANTA_Oldcastle Retail CMP999820_EZ Mix.pkl	Exponential Weighted Average	72.84604355583394
Canada_Expocrete_Acheson.pkl	Exponential Weighted Average	100.00015038173412
Canada_Expocrete_Balzac.pkl	Exponential Weighted Average	100.0
Canada_Expocrete_Edmonton.pkl	Exponential Weighted Average	99.99961050732165
Canada_Expocrete_Richmond.pkl	Sarimax	78.73791935303535
Canada_Expocrete_Saskatoon.pkl	Exponential Weighted Average	100.0
Canada_Expocrete_Winnipeg.pkl	Exponential Weighted Average	43.89612282241068
Canada_Permacon_Milton ON.pkl	Exponential Weighted Average	93.40841190029032
Canada_Permacon_Montreal QC.pkl	Exponential Weighted Average	100.0
Canada_Permacon_Woodstock Ontario.pkl	Exponential Weighted Average	100.02342022191189
Central_Ash Grove MPC_Fort Smith, AR.pkl	Exponential Weighted Average	24.964054484779936
Central_Ash Grove MPC_Fremont, NE.pkl	Exponential Weighted Average	375.3285620132314
Central_Ash Grove MPC_Harrisonville, MO.pkl	Exponential Weighted Average	103.39289457617993
Central_Ash Grove MPC_Jackson, MS.pkl	Exponential Weighted Average	100.0
Central_Ash Grove MPC_Memphis, TN.pkl	Sarimax	31.489738052788713
Central_Ash Grove MPC_Muskogee, OK.pkl	Holt-Winters	40.39735375922514
Central_Ash Grove MPC_North Little Rock, AR.pkl	Exponential Weighted Average	100.0
Central_Ash Grove MPC_Oklahoma City, OK.pkl	Sarimax	28.17529034034666
Central_Jewell_Austin TX (S).pkl	Exponential Weighted Average	39.122600320586734
Central_Jewell_Brittmoore.pkl	Exponential Weighted Average	20.50468017595813
Central_Jewell_Dallas TX (S).pkl	Exponential Weighted Average	22.532908024065136
Central_Jewell_Frisco TX (S).pkl	Exponential Weighted Average	26.138389192554907
Central_Jewell_Houston TX - West Hardy (M).pkl	Exponential Weighted Average	100.0
Central_Jewell_Houston TX-N Garden.pkl	Exponential Weighted Average	109.12115556137559
Central_Jewell_Hurst TX-SAK.pkl	Sarimax	18.93714980288836
Central_Jewell_IBC TX-SAK.pkl	Sarimax	16.83630728688726
Central_Jewell_Katy TX-SAK.pkl	Exponential Weighted Average	98.95650509436827
Central_Jewell_Keller TX (S).pkl	Sarimax	37.70293051078848
Central_Jewell_Marble Falls (SAK).pkl	Exponential Weighted Average	18.877120860764258
Central_Jewell_Rosenberg TX.pkl	Sarimax	90.34990714422648
Central_Jewell_Waco TX.pkl	Sarimax	34.398706464701064
Central_Northfield_Bridgeport MI.pkl	Exponential Weighted Average	100.0
Central_Northfield_Cincinnati OH-SAK.pkl	Sarimax	28.806010790797572
Central_Northfield_Forest View IL.pkl	Sarimax	48.3880667448228
Central_Northfield_Franklin Park IL-SAK.pkl	Sarimax	24.26233643465519
Central_Northfield_Indianapolis IN.pkl	Exponential Weighted Average	98.8563557991144
Central_Northfield_Miller Materials KC Plant.pkl	Exponential Weighted Average	100.0
Central_Northfield_Miller MaterialsBonner Springs.pkl	Exponential Weighted Average	100.0

Central_Northfield_Morris IL.pk1	Exponential Weighted Average	95.94530048466756
Central_Northfield_Mundelein IL.pk1	Exponential Weighted Average	100.0
Central_Northfield_Shakopee.pk1	Exponential Weighted Average	100.00101846491572
Central_Northfield_Sheffield OH.pk1	Sarimax	43.94680397260296
Central_Northfield_West Des Moines IA.pk1	Exponential Weighted Average	105.11927771413707
Central_Northfield_Wisconsin Distribution Yard.pk1	Exponential Weighted Average	100.00971371072625
East_Adams_Products_Anderson SC.pk1	Exponential Weighted Average	97.66752109805478
East_Adams_Products_Asheville NC.pk1	Exponential Weighted Average	46024.075075701665
East_Adams_Products_Charlotte NC Plant.pk1	Sarimax	15.228867759029537
East_Adams_Products_Charlotte NC.pk1	Sarimax	18.720787188078162
East_Adams_Products_Clarksville TN.pk1	Exponential Weighted Average	27.493073325177765
East_Adams_Products_Colfax NC.pk1	Exponential Weighted Average	95.27303263055127
East_Adams_Products_Cowpens SC.pk1	Exponential Weighted Average	105.79780584075186
East_Adams_Products_Durham NC.pk1	Sarimax	21.338261357634916
East_Adams_Products_Fayetteville NC.pk1	Sarimax	28.4594175407765
East_Adams_Products_Franklin NC.pk1	Holt-Winters	82.73159949183567
East_Adams_Products_Franklin TN-SAK.pk1	Sarimax	99.83737915895513
East_Adams_Products_Goldsboro NC.pk1	Exponential Weighted Average	32.963347102458904
East_Adams_Products_Greensboro NC.pk1	Exponential Weighted Average	100.0
East_Adams_Products_Greenville NC.pk1	Sarimax	23.423877805855614
East_Adams_Products_Greenville SC.pk1	Sarimax	20.55964967266661
East_Adams_Products_Hickory NC.pk1	Sarimax	76.97633302110971
East_Adams_Products_HollyHill SC.pk1	Exponential Weighted Average	29.129899980530155
East_Adams_Products_Inman SC.pk1	Sarimax	20.789483313356378
East_Adams_Products_Jacksonville NC.pk1	Exponential Weighted Average	23.608215549474473
East_Adams_Products_Lilesville NC-SAK.pk1	Sarimax	17.3312647336415
East_Adams_Products_Morehead NC.pk1	Exponential Weighted Average	24.415645624522824
East_Adams_Products_Morrisville NC.pk1	Exponential Weighted Average	101.01064206061858
East_Adams_Products_Myrtle Beach SC.pk1	Exponential Weighted Average	105.27048102574177
East_Adams_Products_Nashville TN.pk1	Holt-Winters	62.07611470208617
East_Adams_Products_Rockwood TN.pk1	Exponential Weighted Average	100.0
East_Adams_Products_Rocky Mount NC.pk1	Exponential Weighted Average	99.78616158011658
East_Adams_Products_Stallings NC.pk1	Exponential Weighted Average	41.22157258599648
East_Adams_Products_Wilmington NC.pk1	Exponential Weighted Average	133.22146025996042
East_Adams_Products_Youngsville NC.pk1	Exponential Weighted Average	100.0
East_Anchor_Anchor South Region.pk1	Exponential Weighted Average	100.0
East_Anchor_Batavia NY-SAK.pk1	Sarimax	84.97900543344686
East_Anchor_Brick NJ.pk1	Exponential Weighted Average	98.98800226999953
East_Anchor_Bristol PA-SAK.pk1	Exponential Weighted Average	100.0
East_Anchor_Calverton NY-SAK.pk1	Exponential Weighted Average	132.60729825085
East_Anchor_Canaan CT-SAK.pk1	Exponential Weighted Average	130.3276522308542
East_Anchor_Cranston RI.pk1	Exponential Weighted Average	110.31586627556342

East_Anchor_Crofton MD.pkl	Exponential Weighted Average	98.76073853199384
East_Anchor_East Petersburg PA.pkl	Exponential Weighted Average	97.95066521262498
East_Anchor_Easton PA.pkl	Sarimax	88.42018081882307
East_Anchor_Emigsville PA.pkl	Holt-Winters	21.26391699668475
East_Anchor_Farmingdale NJ.pkl	Exponential Weighted Average	108.99737740741773
East_Anchor_Fishers NY.pkl	Exponential Weighted Average	98.25499259873138
East_Anchor_Fredonia PA-SAK.pkl	Exponential Weighted Average	106.0009230561212
East_Anchor_Holbrook MA.pkl	Sarimax	30.133875276995475
East_Anchor_Keene NH.pkl	Exponential Weighted Average	99.87845231249534
East_Anchor_Lebanon NH.pkl	Exponential Weighted Average	99.45607789528246
East_Anchor_Lyndhurst NJ.pkl	Holt-Winters	95.52719731882337
East_Anchor_Manasquan NJ.pkl	Exponential Weighted Average	100.0
East_Anchor_Milford VA-SAK.pkl	Exponential Weighted Average	100.0
East_Anchor_Oxford MA-SAK.pkl	Sarimax	28.056116917134617
East_Anchor_White Marsh MD-SAK.pkl	Exponential Weighted Average	113.69752232431726
East_Anchor_Winchester VA.pkl	Sarimax	26.20801396576699
East_Georgia Masonry Supply_Cartersville GA BLOCK.pkl	Exponential Weighted Average	24.42777555327033
East_Georgia Masonry Supply_Conley GA-SAK.pkl	Sarimax	16.525061158020062
East_Georgia Masonry Supply_Florence AL.pkl	Exponential Weighted Average	35.40394523797486
East_Georgia Masonry Supply_Jasper AL.pkl	Holt-Winters	98.55454068225514
East_Georgia Masonry Supply_Jonesboro GA.pkl	Exponential Weighted Average	100.22939459511963
East_Georgia Masonry Supply_Lawrenceville GA DIST.pkl	Sarimax	26.702419522567922
East_Georgia Masonry Supply_Lawrenceville GA MANF.pkl	Exponential Weighted Average	25.788291832201804
East_Georgia Masonry Supply_Macon GA.pkl	Exponential Weighted Average	23.651414988441168
East_Georgia Masonry Supply_Montgomery AL.pkl	Exponential Weighted Average	101.77825290565627
East_Georgia Masonry Supply_Pelham AL.pkl	Exponential Weighted Average	117.44292478912202
East_Georgia Masonry Supply_Tyrone GA.pkl	Exponential Weighted Average	26.153977550897373
East_OldcastleCoastal_Auburndale FL-SAK.pkl	Exponential Weighted Average	103.2979706188381
East_OldcastleCoastal_Defuniak.pkl	Holt-Winters	27.215327068415945
East_OldcastleCoastal_Fort Myers FL.pkl	Exponential Weighted Average	23.69317236423318
East_OldcastleCoastal_Fort Pierce FL.pkl	Exponential Weighted Average	102.21474299217333
East_OldcastleCoastal_Gainesville FL.pkl	Exponential Weighted Average	98.41049590049002
East_OldcastleCoastal_Gulfport MS.pkl	Sarimax	30.256561535624538
East_OldcastleCoastal_Haines City FL Hardscapes.pkl	Exponential Weighted Average	101.13980746499386
East_OldcastleCoastal_Jacksonville FL-SAK.pkl	Sarimax	20.172252697148974
East_OldcastleCoastal_Jacksonville FL.pkl	Exponential Weighted Average	100.99649969572322
East_OldcastleCoastal_Lehigh Acres FL.pkl	Exponential Weighted Average	100.0
East_OldcastleCoastal_Longwood FL.pkl	Exponential Weighted Average	22.362843151522654
East_OldcastleCoastal_Orlando FL.pkl	Exponential Weighted Average	16.030745604980574
East_OldcastleCoastal_Pensacola FL-SAK.pkl	Sarimax	25.06098445435501
East_OldcastleCoastal_Pompano FL Hardscapes.pkl	Exponential Weighted Average	123.44227303740647
East_OldcastleCoastal_Pompano FL-SAK.pkl	Sarimax	14.807996915502923

East_OldcastleCoastal_Sarasota FL.pkl	Exponential Weighted Average	102.58195051779452
East_OldcastleCoastal_Tampa FL - Anderson Rd.pkl	Exponential Weighted Average	16.50049849914757
East_OldcastleCoastal_Tampa FL - Busch Blvd.pkl	Exponential Weighted Average	99.98818208408984
East_OldcastleCoastal_Tampa FL-SAK.pkl	Exponential Weighted Average	18.91384015251571
East_OldcastleCoastal_Theodore AL.pkl	Sarimax	101.26796017028342
East_OldcastleCoastal_West Palm Beach FL.pkl	Exponential Weighted Average	15.364590368115765
East_OldcastleCoastal_Zephyrhills FL.pkl	Exponential Weighted Average	99.9997093542163
Lawn and Garden_L&G Central_Aliceville AL.pkl	Exponential Weighted Average	81.48293940687725
Lawn and Garden_L&G Central_Amherst Junction WI.pkl	Exponential Weighted Average	66.46036321324605
Lawn and Garden_L&G Central_Bridgeport MI.pkl	Exponential Weighted Average	101.26604638448387
Lawn and Garden_L&G Central_Cleveland, TX.pkl	Exponential Weighted Average	100.09364758704248
Lawn and Garden_L&G Central_Dallas TX.pkl	Exponential Weighted Average	100.0
Lawn and Garden_L&G Central_Del Valle, TX.pkl	Holt-Winters	48.59199659094988
Lawn and Garden_L&G Central_Harrah OK.pkl	Exponential Weighted Average	75.83808666944728
Lawn and Garden_L&G Central_Hope AR.pkl	Sarimax	55.813905859673405
Lawn and Garden_L&G Central_Livingston TX.pkl	Exponential Weighted Average	99.99985725118438
Lawn and Garden_L&G Central_Marseilles IL.pkl	Exponential Weighted Average	102.76240541185133
Lawn and Garden_L&G Central_Miami OK.pkl	Exponential Weighted Average	100.00032626047191
Lawn and Garden_L&G Central_Paola KS.pkl	Sarimax	86.99028254916958
Lawn and Garden_L&G Central_Powderly TX.pkl	Sarimax	55.54774802006895
Lawn and Garden_L&G Central_Sauget IL.pkl	Exponential Weighted Average	67.45553693490703
Lawn and Garden_L&G Central_Tulia TX.pkl	Exponential Weighted Average	56.187079247518014
Lawn and Garden_L&G Central_Tylertown MS.pkl	Exponential Weighted Average	98.89571328472938
Lawn and Garden_L&G Central_Waterloo IN.pkl	Sarimax	106.21189409063123
Lawn and Garden_L&G Northeast_Berlin NY.pkl	Exponential Weighted Average	100.0
Lawn and Garden_L&G Northeast_Carey OH.pkl	Exponential Weighted Average	44.91671398412932
Lawn and Garden_L&G Northeast_Castlewood VA.pkl	Exponential Weighted Average	100.0
Lawn and Garden_L&G Northeast_Chatsworth GA.pkl	Exponential Weighted Average	101.65545185175095
Lawn and Garden_L&G Northeast_Historical-Co-Packer.pkl	Exponential Weighted Average	90.44361201481476
Lawn and Garden_L&G Northeast_Hooksett NH.pkl	Sarimax	96.29499216764816
Lawn and Garden_L&G Northeast_Lee MA.pkl	Sarimax	40.93788741700914
Lawn and Garden_L&G Northeast_Manchester NY.pkl	Exponential Weighted Average	100.0
Lawn and Garden_L&G Northeast_Mount Hope NJ.pkl	Exponential Weighted Average	100.00012738607981
Lawn and Garden_L&G Northeast_Poland Spring ME.pkl	Exponential Weighted Average	99.99967132056334
Lawn and Garden_L&G Northeast_Quakertown PA.pkl	Exponential Weighted Average	99.99400806464868
Lawn and Garden_L&G Northeast_Thomasville PA.pkl	Exponential Weighted Average	99.99749514233368
Lawn and Garden_L&G Northeast_Wyoming RI.pkl	Exponential Weighted Average	100.0
Lawn and Garden_L&G Southeast_Aberdeen NC.pkl	Exponential Weighted Average	101.44943459423624
Lawn and Garden_L&G Southeast_Bostwick FL.pkl	Holt-Winters	87.42880215688001
Lawn and Garden_L&G Southeast_Cross City FL.pkl	Exponential Weighted Average	100.0
Lawn and Garden_L&G Southeast_Davenport FL.pkl	Exponential Weighted Average	106.20359447503871
Lawn and Garden_L&G Southeast_Fort Green FL.pkl	Exponential Weighted Average	99.99971010381621

Lawn and Garden_L&G Southeast_Gaffney SC.pkl	Exponential Weighted Average	100.0
Lawn and Garden_L&G Southeast_Louisburg NC.pkl	Exponential Weighted Average	100.0
Lawn and Garden_L&G Southeast_Moore Haven FL.pkl	Holt-Winters	80.01529384140485
Lawn and Garden_L&G Southeast_Pageland SC.pkl	Exponential Weighted Average	100.0
Lawn and Garden_L&G Southeast_Shady Dale GA.pkl	Exponential Weighted Average	100.0
Lawn and Garden_L&G Southeast_Walterboro SC.pkl	Exponential Weighted Average	100.0
National_AMTC_Saint Paul MN.pkl	Holt-Winters	45.62618922538426
National_Anchor Wall Systems_Minnetonka MN.pkl	Exponential Weighted Average	100.20350697742518
National_MoistureShield_Springdale AR.pkl	Exponential Weighted Average	100.0
National_Oldcastle Sakerete Billing_Easy Mix.pkl	Sarimax	46.75687619120704
National_Oldcastle Sakerete Billing_Roberts Concrete.pkl	Sarimax	34.060171110587195
National_Oldcastle Sakerete Billing_US Mix.pkl	Sarimax	27.03247068672397
National_Techniseal_Ash Grove Memphis.pkl	Exponential Weighted Average	76.20696143586312
National_Techniseal_Ash Grove Nebraska.pkl	Exponential Weighted Average	98.96178464379707
National_Techniseal_Candiac.pkl	Sarimax	70.78811544362111
National_Techniseal_Coastal Tampa.pkl	Holt-Winters	324.75692324050607
National_Techniseal_CPM Portland.pkl	Exponential Weighted Average	194.89456578973926
National_Techniseal_Ectra.pkl	Sarimax	964.6157699569834
National_Techniseal_Eurl Leps Mehat.pkl	Holt-Winters	262.7640934630769
National_Techniseal_EZ Mix.pkl	Holt-Winters	50.955654735940705
National_Techniseal_Handy Concrete.pkl	Sarimax	86.82551019933835
National_Techniseal_PTB Compaktuna.pkl	Holt-Winters	116.22389149982415
National_Techniseal_Ras.pkl	Holt-Winters	164.20411923180336
National_Techniseal_Techmix.pkl	Exponential Weighted Average	52.47062612771786
National_Westtile_Westtile Roofing Products.pkl	Sarimax	14.768028882350945
West_Amcor_North Salt Lake UT.pkl	Exponential Weighted Average	98.22454557179093
West_CPM_Frederickson, WA.pkl	Sarimax	233.76454558151337
West_CPM_Kent, WA.pkl	Exponential Weighted Average	102.49553751118567
West_CPM_Northstar Consignment.pkl	Exponential Weighted Average	312.2972920876084
West_CPM_Pasco WA.pkl	Exponential Weighted Average	116.11403323452119
West_CPM_Portland, OR.pkl	Exponential Weighted Average	101.56253206273279
West_CPM_Spokane, WA.pkl	Exponential Weighted Average	100.0
West_Sierra_Fontana CA.pkl	Exponential Weighted Average	92.45907005595387
West_Sierra_Reno NV.pkl	Exponential Weighted Average	96.93968916927118
West_Sierra_San Carlos CA.pkl	Exponential Weighted Average	615.7309246060131
West_Sierra_Stockton CA.pkl	Exponential Weighted Average	98.29301536894833
West_Superlite_Gilbert, AZ.pkl	Holt-Winters	85.08110075416826
West_Superlite_Integra Product.pkl	Exponential Weighted Average	100.0
West_Superlite_Lone Butte.pkl	Holt-Winters	90.34668813870861
West_Superlite_North Las Vegas.pkl	Exponential Weighted Average	100.0
West_Superlite_Superlite - Western 19th Ave.pkl	Exponential Weighted Average	20.59434988628568
West_Superlite_Tucson, AZ - Gardner Ln.pkl	Exponential Weighted Average	101.83952541132857

	West_Superlite_West Phoenix N. 42nd Ave, AZ.pkl		Exponential Weighted Average		99.78844048344257	
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Count of each Best Model on Differenced Data

```
In [22]: sari = 0
hw = 0
se = 0
for i in best_models:
    if i == 'Sarimax':
        sari += 1
    elif i == 'Holt-Winters':
        hw += 1
    else:
        se += 1

print('Number of Holt-Winters Best models: ', hw)
print('Number of Sarimax Best models: ', sari)
print('Number of Exponential Weighted Avg Best models: ', se)
```

```
Number of Holt-Winters Best models: 18
Number of Sarimax Best models: 48
Number of Exponential Weighted Avg Best models: 141
```

```
In [14]: print('Lower bound of results: ', np.min(best_scores))
print('Upper bound of results: ', np.max(best_scores))
```

```
Lower bound of results: 14.768028882350945
Upper bound of results: 46024.075075701665
```

Best Models

- SARIMAX
 - If this is our best model we can conclude that our data of the unique combination contains trend as well as seasonality, as SARIMAX model is an extension of ARIMA model its prime purpose is to capture seasonality in the data and give insights regarding the data
- Holt-Winters Model
 - This model also captures trend and seasonality of our data, as this model runs on triple exponential smoothing. It can give us insights which our sarimax model couldn't give. So, we are trying to capture trend and seasonality of our data using another model which runs on completely different algorithm. This will inturn gaurantee our data's trend and seasonality
- Exponential Weighted Avg
 - This model does not capture trend or seasonality, so if this is our best model we know that our underlying data does not have any trend or seasonality. It might be random or cyclic. Simple Exponential forecasting model prediction is a weighted sum of past observations, but the model explicitly uses an exponentially decreasing weight for past observations. Specifically, past observations are weighted with a geometrically decreasing ratio.
- LSTM
 - LSTM unit is a type of Recurrent Neural Network. LSTM is a sequential model and the whole purpose is not just solving time series problem but it is also built for NLP problems as well. This inturn affects the time sries problem. for ex: if your data is not seasonal and the season at N year is differing from season at N-1 then it will affect your LSTM model in a negative way as it only learns from the past sequence of data. so we can conclude the if LSTM is our best model then for sure we have seasonality in our data and trend as well.
 - Another disadavantage we have for LSTM is that we don't have many hyperparameters, sure we can reduce overfitting through correct regularization parameters or dropout parameters but since it doesn't have any parameters the same model keeps running for all data. Compared to our classical methods we can find best parameters for each time series data and fit our model with the suitable hyperparameters.
 - To improve our LSTM model we can use ensembles of LSTM units which will inturn improve our performance metric

Observations

- Based on the best model we can understand our data, if it is trending, seasonal etc.
- Now, based on those insights we can look at the products which each unique combination of "Region Department Facility" is offering
- This insight of their products based on our best models will help us to do better Market Research and understanding of why the respective sales are increasing or decreasing
- We can then consult the clients based on this analysis with proper reports and give conclusions on the scale of manufacturing to be done of their respective products

Conclusion

- Log Transformation is the better Transformation technique
- We now have our best models for each good unique combination of "Region Department Facility", this will now save us time in the future when we are given similar data
- Most frequent best model is SARIMAX model for our log transformed data