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EVALUATING ERROR IN DEMAND FORECASTING ERROR CALCULATION DUE TO MINIMUM DEMAND DURING COVID '19 LOCKDOWN

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Abstract - The COVID '19 has impacted deep without any doubt. It has even tweaked a well-established system to reconsider their basics. One of such basics is the estimation of demand or Forecasting. With the reopening of the economy, everybody is struggling with the estimation of demand. This paper is proposing a way to consolidate the data and it is suggesting ways to pamper the older data and just what to do with the numbers accumulated during lockdown times. The concept to proceed was very simple – "Numbers don't lie." Older available data was accumulated, filtered, put into the formulated flames and compared. Analysis was an eye opener and clear cut message was to just shut the eye towards data from pandemic.

Keywords: Demand, Demand Forecasting, Forecasting, COVID, Pandemic, Industrial Engineering, MAD, MAPE, Exponential Smoothing, Weighted Moving Average, WMA, Moving Average, Holt's Method.

1. INTRODUCTION

Demand forecasting is a process of predicting the demand for an organization's products or services in a specified time period in the future. Demand forecasting is helpful for both new as well as existing organizations in the market. Methods of demand forecasting are broadly categorized into two types – (i) Qualitative Techniques and (ii) Quantitative Techniques. Quantitative techniques are more reliable as they have a data as the backup. They may be further categorized into (a) Time Series Analysis and (b) Regression Analysis. Moreover, Time series analysis have several methods like Data Average Method, Moving Average Method, Weighted Moving Average Method and Exponential Smoothing.

A small sized paper supplier was chosen as the source of the data. Company's name is Saurabh Paper Company and for our research we chose 75gms-A4 Sheet reams, which they supply. They buy a ream for Rs. 105 per ream and sell it at Rs. 170 – 190 per ream. Company has a limited space to stock the paper. They may expand the storage, but the sales projections are not allowing it to happen. COVID pandemic hit them hard and they are willing to reconsider their plan to inject themselves again in supply chain. This is where we are going to help them consider our data, which we prepared for something which is consumed and doesn't expire.

2. OBJECTIVE

The inspiration driving this report is to add to the current data on business forecasting through a contextual analysis. For the situation study, unmistakable quantitative forecasting models are applied on recorded data to balance them with the critical forecasting estimates used at Saurabh Paper Company. The disclosures of the contextual analysis will be diverged from theories perceived in the insightful composition. "The proposition moreover target contributing theoretically by discussing if the quantitative forecasting models considered and proposed by various experts have not limited utilitarian repercussions, as the methodologies might be exorbitantly quantifiably complex to be of any usage of genuine firms, yet may be implemented if practiced."

3. METHODOLOGY

Procedure is very basic. As soon as the objective was defined, a clear and correct path was seen. To collect a reliable data, work on the data over a tested model, generate a result and reach to a conclusion.

- Thesis scope defined together with the demand manager at Saurabh Paper Company.
- Interviews with sales manager and key personnel at sales offices.
- Model building and model testing.
- Analysis based on the findings from tested models and from the information gained through interviews.
- Recommendations.
- Analysis and discussion whether forecasting methods proposed by researchers have any practical value to actual firms.

4. DATA COLLECTION AND REVIEW

With the available actual demand data, the data were churned and forecasting for each months were calculated by past average method, 3 month moving average method, 6 month moving average method, 3 month weighted moving average method, 6 month weighted moving average method, exponential smoothing method with $\alpha = 0.8$ and exponential smoothing method with $\alpha = 0.3$. After this, error on each methods were calculated by mean absolute deviation, mean square error, root mean square error, mean absolute percentage error and mean deviation error. Later, the data from the month of pandemic was eliminated and again the calculations were made. Error on calculations were again computed and finally both the consolidated data were compared.

Table – 1: Forecasting by all Time Series methods by actual demand data

	ACTUAL DEMAND	PAST DATA AVERAGES	3 MONTH MOVING AVERAGE	6 MONTH MOVING AVERAGE	3 MONTH WEIGHTED MOVING AVERAGE	6 MONTH WEIGHTED MOVING AVERAGE	EXPONENTIAL SMOOTHING (Holt's Model) Alpha = 0.8	EXPONENTIAL SMOOTHING (Holt's Model) Alpha = 0.3
Jan-18	1900	1900	--	--	--	--	1900	1900
Feb-18	2250	2075	--	--	--	--	2180	2005
Mar-18	2650	2267	2267	--	2392	--	2556	2199
Apr-18	2550	2338	2483	--	2533	--	2551	2304
May-18	2050	2280	2417	--	2317	--	2150	2228
Jun-18	2050	2242	2217	2242	2133	2243	2070	2174
Jul-18	1800	2179	1967	2225	1925	2117	1854	2062
Aug-18	1850	2138	1900	2158	1867	2010	1851	1998
Sep-18	2000	2122	1883	2050	1917	1964	1970	1999
Oct-18	2100	2120	1983	1975	2025	1979	2074	2029
Nov-18	2000	2109	2033	1967	2033	1986	2015	2020
Dec-18	2100	2108	2067	1975	2067	2024	2083	2044
Jan-19	2100	2108	2067	2025	2083	2060	2097	2061
Feb-19	2450	2132	2217	2125	2275	2181	2379	2178
Mar-19	3100	2197	2550	2308	2717	2460	2956	2454
Apr-19	2750	2231	2767	2417	2817	2586	2791	2543
May-19	2300	2235	2717	2467	2583	2552	2398	2470
Jun-19	2500	2250	2517	2533	2475	2562	2480	2479
Jul-19	2050	2239	2283	2525	2242	2424	2136	2350
Aug-19	2000	2228	2183	2450	2100	2274	2027	2245
Sep-19	2400	2236	2150	2333	2208	2260	2325	2292
Oct-19	2550	2250	2317	2300	2408	2321	2505	2369
Nov-19	2350	2254	2433	2308	2425	2336	2381	2363
Dec-19	2150	2250	2350	2250	2283	2290	2196	2299
Jan-20	2150	2246	2217	2267	2183	2262	2159	2255
Feb-20	2600	2260	2300	2367	2375	2357	2512	2358
Mar-20	3400	2302	2717	2533	2925	2652	3222	2671
Apr-20	800	2248	2267	2242	1967	2157	1284	2110
May-20	200	2178	1467	1883	933	1574	417	1537
Jun-20	350	2117	450	1583	375	1136	363	1181
Jul-20	1650	2102	733	1500	975	1155	1393	1321
Aug-20	1700	2089	1233	1350	1458	1212	1639	1435

Table – 2: Error calculation on Past data averages

	ACTUAL DEMAND	PAST DATA AVERAGES	BASIC ERROR (D-F)	MAD - ABSOLUTE ERROR |D-F|	MSE & RMSE - ERROR SQUARE	MAPE - ABSOLUTE (ERROR/DEMAND)
Jan-18	1900	1900	0	0	0	0.00
Feb-18	2250	2075	350	350	122500	0.16
Mar-18	2650	2267	575	575	330625	0.22
Apr-18	2550	2338	283	283	80278	0.11
May-18	2050	2280	-288	288	82656	0.14
Jun-18	2050	2242	-230	230	52900	0.11
Jul-18	1800	2179	-442	442	195069	0.25
Aug-18	1850	2138	-329	329	107959	0.18
Sep-18	2000	2122	-138	138	18906	0.07
Oct-18	2100	2120	-22	22	494	0.01
Nov-18	2000	2109	-120	120	14400	0.06
Dec-18	2100	2108	-9	9	83	0.00
Jan-19	2100	2108	-8	8	69	0.00
Feb-19	2450	2132	342	342	117175	0.14
Mar-19	3100	2197	968	968	936747	0.31
Apr-19	2750	2231	553	553	306178	0.20
May-19	2300	2235	69	69	4727	0.03
Jun-19	2500	2250	265	265	70069	0.11
Jul-19	2050	2239	-200	200	40000	0.10
Aug-19	2000	2228	-239	239	57348	0.12
Sep-19	2400	2236	173	173	29756	0.07
Oct-19	2550	2250	314	314	98776	0.12
Nov-19	2350	2254	100	100	10000	0.04
Dec-19	2150	2250	-104	104	10888	0.05
Jan-20	2150	2246	-100	100	10000	0.05
Feb-20	2600	2260	354	354	125316	0.14
Mar-20	3400	2302	1140	1140	1300477	0.34
Apr-20	800	2248	-1502	1502	2255559	1.88
May-20	200	2178	-2048	2048	4195182	10.24
Jun-20	350	2117	-1828	1828	3340071	5.22
Jul-20	1650	2102	-467	467	217778	0.28
Aug-20	1700	2089	-402	402	161293	0.24
			-2988	13961	14293279	21

Table – 3: Error calculation on 3 Month Moving Average Method

	ACTUAL DEMAND	3 MONTH MOVING AVERAGE	BASIC ERROR (D-F)	MAD - ABSOLUTE ERROR |D-F|	MSE & RMSE - ERROR SQUARE	MAPE - ABSOLUTE (ERROR/DEMAND)
Jan-18	1900	--	0	0	0	0.00
Feb-18	2250	--	0	0	0	0.00
Mar-18	2650	2267	283	283	80278	0.11
Apr-18	2550	2483	283	283	80278	0.11
May-18	2050	2417	-433	433	187778	0.21
Jun-18	2050	2217	-367	367	134444	0.18
Jul-18	1800	1967	-417	417	173611	0.23
Aug-18	1850	1900	-117	117	13611	0.06
Sep-18	2000	1883	100	100	10000	0.05
Oct-18	2100	1983	217	217	46944	0.10
Nov-18	2000	2033	17	17	278	0.01
Dec-18	2100	2067	67	67	4444	0.03
Jan-19	2100	2067	33	33	1111	0.02
Feb-19	2450	2217	383	383	146944	0.16
Mar-19	3100	2550	883	883	780278	0.28
Apr-19	2750	2767	200	200	40000	0.07
May-19	2300	2717	-467	467	217778	0.20
Jun-19	2500	2517	-217	217	46944	0.09
Jul-19	2050	2283	-467	467	217778	0.23
Aug-19	2000	2183	-283	283	80278	0.14
Sep-19	2400	2150	217	217	46944	0.09
Oct-19	2550	2317	400	400	160000	0.16
Nov-19	2350	2433	33	33	1111	0.01
Dec-19	2150	2350	-283	283	80278	0.13
Jan-20	2150	2217	-200	200	40000	0.09
Feb-20	2600	2300	383	383	146944	0.15
Mar-20	3400	2717	1100	1100	1210000	0.32
Apr-20	800	2267	-1917	1917	3673611	2.40
May-20	200	1467	-2067	2067	4271111	10.33
Jun-20	350	450	-1117	1117	1246944	3.19
Jul-20	1650	733	1200	1200	1440000	0.73
Aug-20	1700	1233	967	967	934444	0.57
			-1583	15117	15514167	20

Table – 4: Error calculation on 3 Month Weighted Moving Average Method

	ACTUAL DEMAND	3 MONTH WEIGHTED MOVING AVERAGE	BASIC ERROR (D-F)	MAD - ABSOLUTE ERROR |D-F|	MSE & RMSE - ERROR SQUARE	MAPE - ABSOLUTE (ERROR/DEMAND)
Jan-18	1900	--	0	0	0	0.00
Feb-18	2250	--	0	0	0	0.00
Mar-18	2650	2392	158	158	25069	0.06
Apr-18	2550	2533	-483	483	233611	0.19
May-18	2050	2317	-267	267	71111	0.13
Jun-18	2050	2133	-333	333	111111	0.16
Jul-18	1800	1925	-75	75	5625	0.04
Aug-18	1850	1867	133	133	17778	0.07
Sep-18	2000	1917	183	183	33611	0.09
Oct-18	2100	2025	-25	25	625	0.01
Nov-18	2000	2033	67	67	4444	0.03
Dec-18	2100	2067	33	33	1111	0.02
Jan-19	2100	2083	367	367	134444	0.17
Feb-19	2450	2275	825	825	680625	0.34
Mar-19	3100	2717	33	33	1111	0.01
Apr-19	2750	2817	-517	517	266944	0.19
May-19	2300	2583	-83	83	6944	0.04
Jun-19	2500	2475	-425	425	180625	0.17
Jul-19	2050	2242	-242	242	58403	0.12
Aug-19	2000	2100	300	300	90000	0.15
Sep-19	2400	2208	342	342	116736	0.14
Oct-19	2550	2408	-58	58	3403	0.02
Nov-19	2350	2425	-275	275	75625	0.12
Dec-19	2150	2283	-133	133	17778	0.06
Jan-20	2150	2183	417	417	173611	0.19
Feb-20	2600	2375	1025	1025	1050625	0.39
Mar-20	3400	2925	-2125	2125	4515625	0.63
Apr-20	800	1967	-1767	1767	3121111	2.21
May-20	200	933	-583	583	340278	2.92
Jun-20	350	375	1275	1275	1625625	3.64
Jul-20	1650	975	725	725	525625	0.44
Aug-20	1700	1458	-1458	1458	2126736	0.86
			-2967	14733	15615972	14

Table – 5: Error calculation on Exponential Smoothing Method when α = 0.3

	ACTUAL DEMAND	EXPONENTIAL SMOOTHING (Holt's Model) Alpha = 0.3	BASIC ERROR (D-F)	MAD - ABSOLUTE ERROR |D-F|	MSE & RMSE - ERROR SQUARE	MAPE - ABSOLUTE (ERROR/DEMAND)
Jan-18	1900	1900	0	0	0	0.00
Feb-18	2250	2005	350	350	122500	0.16
Mar-18	2650	2199	645	645	416025	0.24
Apr-18	2550	2304	352	352	123552	0.14
May-18	2050	2228	-254	254	64491	0.12
Jun-18	2050	2174	-178	178	31600	0.09
Jul-18	1800	2062	-374	374	140202	0.21
Aug-18	1850	1998	-212	212	44988	0.11
Sep-18	2000	1999	2	2	2	0.00
Oct-18	2100	2029	101	101	10215	0.05
Nov-18	2000	2020	-29	29	856	0.01
Dec-18	2100	2044	80	80	6324	0.04
Jan-19	2100	2061	56	56	3099	0.03
Feb-19	2450	2178	389	389	151295	0.16
Mar-19	3100	2454	922	922	850594	0.30
Apr-19	2750	2543	296	296	87376	0.11
May-19	2300	2470	-243	243	59090	0.11
Jun-19	2500	2479	30	30	890	0.01
Jul-19	2050	2350	-429	429	184137	0.21
Aug-19	2000	2245	-350	350	122765	0.18
Sep-19	2400	2292	155	155	23943	0.06
Oct-19	2550	2369	258	258	66727	0.10
Nov-19	2350	2363	-19	19	368	0.01
Dec-19	2150	2299	-213	213	45551	0.10
Jan-20	2150	2255	-149	149	22320	0.07
Feb-20	2600	2358	345	345	119316	0.13
Mar-20	3400	2671	1042	1042	1085337	0.31
Apr-20	800	2110	-1871	1871	3499681	2.34
May-20	200	1537	-1910	1910	3646268	9.55
Jun-20	350	1181	-1187	1187	1408172	3.39
Jul-20	1650	1321	469	469	220275	0.28
Aug-20	1700	1435	379	379	143288	0.22
			-1550	13288	12701247	18.83

Now, if we can compile the data, a consolidated picture is created.

Table – 6: Consolidated data (Unedited)

	MAD (MEAN ABSOLUTE DEVIATION)	MSE (MEAN SQUARE ERROR)	RMSE (ROOT MEAN SQUARE METHOD)	MAPE (MEAN ABSOLUTE PERCENTAGE ERROR)	MD (MEAN DEVIATION)
PAST DATA AVERAGES	450.36	461073.52	679.02	68%	-96.39
3 MONTH MOVING AVERAGE	511.49	532203.07	729.52	70%	-64.37
6 MONTH MOVING AVERAGE	454.81	503149.04	709.33	75%	-138.78
3 MONTH WEIGHTED MOVING AVERAGE	457.76	465146.07	682.02	59%	-52.01
6 MONTH WEIGHTED MOVING AVERAGE	468.68	484269.58	695.89	72%	-96.89
EXPONENTIAL SMOOTHING (Holt's Model) Alpha = 0.8	**391.02**	**384562.78**	**620.13**	**40%**	**-10.54**
EXPONENTIAL SMOOTHING (Holt's Model) Alpha = 0.3	415.25	396913.97	630.01	59%	-48.43

Table – 7: Consolidated data (after deleting data from Lockdown Months)

	MAD (MEAN ABSOLUTE DEVIATION)	MSE (MEAN SQUARE ERROR)	RMSE (ROOT MEAN SQUARE METHOD)	MAPE (MEAN ABSOLUTE PERCENTAGE ERROR)	MD (MEAN DEVIATION)
PAST DATA AVERAGES	285.75	152718.38	390.79	12%	120.66
3 MONTH MOVING AVERAGE	315.28	161157.41	401.44	13%	44.44
6 MONTH MOVING AVERAGE	297.62	167308.20	409.03	12%	68.25
3 MONTH WEIGHTED MOVING AVERAGE	283.33	140040.51	374.22	12%	**40.28**
6 MONTH WEIGHTED MOVING AVERAGE	290.14	155704.84	394.59	12%	69.27
EXPONENTIAL SMOOTHING (Holt's Model) Alpha = 0.8	**267.46**	**120121.97**	**346.59**	**11%**	63.58
EXPONENTIAL SMOOTHING (Holt's Model) Alpha = 0.3	287.44	145521.59	381.47	12%	98.81

5. RESULT

The consolidated data presented a very broad view of data that, only three month of major downfall in demand lead to a change in 55% change in error. These three months just escalated the discussion that quantitative approach of forecasting is better than qualitative approach or not. In times of super software, heavy data storage and fast calculations, the center of discussion was which way of time series method is optimum. Following comparison will help remove the cloud of doubt that unexpected factors are still enemy of good results.

Table – 8: Comparing consolidated result of pre and post lockdown data

	MAD (MEAN ABSOLUTE DEVIATION)	MSE (MEAN SQUARE ERROR)	RMSE (ROOT MEAN SQUARE METHOD)	MAPE (MEAN ABSOLUTE PERCENTAGE ERROR)	MD (MEAN DEVIATION)
PAST DATA AVERAGES	450.36	461073.52	679.02	68%	-96.39
	285.75	152718.38	390.79	12%	120.66
3 MONTH MOVING AVERAGE	511.49	532203.07	729.52	70%	-64.37
	315.28	161157.41	401.44	13%	44.44
6 MONTH MOVING AVERAGE	454.81	503149.04	709.33	75%	-138.78
	297.62	167308.20	409.03	12%	68.25
3 MONTH WEIGHTED MOVING AVERAGE	457.76	465146.07	682.02	59%	-52.01
	283.33	140040.51	374.22	12%	40.28
6 MONTH WEIGHTED MOVING AVERAGE	468.68	484269.58	695.89	72%	-96.89
	290.14	155704.84	394.59	12%	69.27
EXPONENTIAL SMOOTHING (Holt's Model) Alpha = 0.8	391.02	384562.78	620.13	40%	-10.54
	267.46	120121.97	346.59	11%	63.58
EXPONENTIAL SMOOTHING (Holt's Model) Alpha = 0.3	415.25	396913.97	630.01	59%	-48.43
	287.44	145521.59	381.47	12%	98.81

6. CONCLUSION

If we can just conclude what we see with numbers that a surge in error is seen in just three months. With the approach of productivity, dependency on data may backfire. The difference between any methods are obvious.

Table – 9: Difference between error calculations

	MAD (MEAN ABSOLUTE DEVIATION)		MSE (MEAN SQUARE ERROR)		RMSE (ROOT MEAN SQUARE METHOD)		MAPE (MEAN ABSOLUTE PERCENTAGE ERROR)		MD (MEAN DEVIATION)
PAST DATA AVERAGES	450.36	164.61	461073.52	308355.14	679.02	288.23	68%	56%	-96.39
	285.75		152718.38		390.79		12%		120.66
3 MONTH MOVING AVERAGE	511.49	196.22	532203.07	371045.66	729.52	328.08	70%	57%	-64.37
	315.28		161157.41		401.44		13%		44.44
6 MONTH MOVING AVERAGE	454.81	157.19	503149.04	335840.84	709.33	300.30	75%	63%	-138.78
	297.62		167308.20		409.03		12%		68.25
3 MONTH WEIGHTED MOVING AVERAGE	457.76	174.43	465146.07	325105.56	682.02	307.80	59%	47%	-52.01
	283.33		140040.51		374.22		12%		40.28
6 MONTH WEIGHTED MOVING AVERAGE	468.68	178.55	484269.58	328564.74	695.89	301.30	72%	60%	-96.89
	290.14		155704.84		394.59		12%		69.27
EXPONENTIAL SMOOTHING (Holt's Model) Alpha = 0.8	391.02	123.56	384562.78	264440.82	620.13	273.55	40%	29%	-10.54
	267.46		120121.97		346.59		11%		63.58
EXPONENTIAL SMOOTHING (Holt's Model) Alpha = 0.3	415.25	127.82	396913.97	251392.38	630.01	248.54	59%	47%	-48.43
	287.44		145521.59		381.47		12%		98.81

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